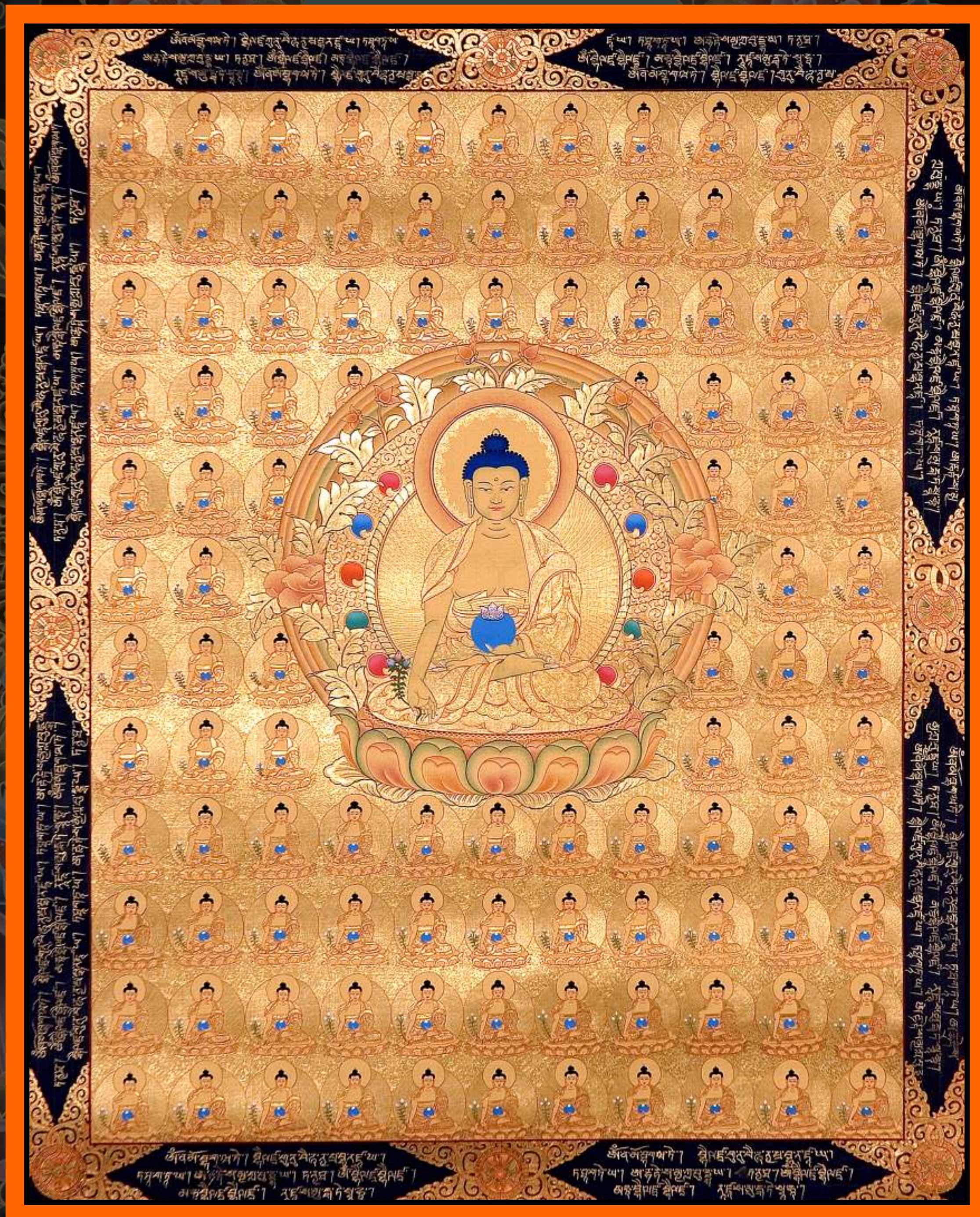
Aspects of Traditional Medicine in Nepal

MOHAN BIKRAM GEWALI



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Preface

The world is culturally endowed with various forms of traditional healing practices. Immediately the names of the Ayurveda of the Indian subcontinent, the Traditional Chinese Medicine of China, the Kampo of Japan, the Tibetan Medicine, the Unani and others come to mind. Such traditional medical system is time tested and contains rich medical wisdom of immense importance. They need to be explained to both specialists and general readers as well.

The book is an attempt to describe some of the basic elements of the traditional medicine and medicinal plant resources of Nepal. Care has been taken to present the material in simple and readable English. It is intended for the general readers, students and anybody who is interested in Nepali traditional medicine and medicinal plant resources. Admittedly, the third chapter of the book appears to be little technical, but it has also been made as understandable as possible. Constructive criticism and comments are most welcome from the readers. Such feedbacks are sure to make the second edition more informative and readable.

This book is one of the outcomes of my tenure as a visiting professor at the Institute of Natural Medicine, University of Toyama during November 2007 to March 2009. I am obliged to the Professor Committee of Institute of Natural Medicine, University of Toyama for offering me this Visiting Professorship. I would also like to express my sincere thanks to Prof. Tokuso Saito, (President, University of Toyama), Prof. Ikuo Saiki (Director, Institute of Natural Medicine) and Prof. Shigetoshi Kadota (Division of Natural Products Chemistry, Institute of Natural Medicine) for taking the necessary steps for realizing this invitation. I have high admiration of Assistant Professor Dr. Suresh Awale who took well care of me during my stay in Toyama. Furthermore, Dr. Awale took pain to edit this book and made it more attractive. It gives me great pleasure to write that Institute of Natural Medicine generously published the book. I would also like to acknowledge the following person for their assistance in different ways: Mr. Bhupendra Bahadur Karki, Kathmandu; Dr. Kamdev Jha, Kathmandu; Mr. Subarna Vaidya, Kathmandu; Mr. Som Prasad Nepal (Sambhu), Kathmandu; Prof. Pramod Kumar Jha, Kathmandu; Prof. Ram Prasad Chaudhary, Kathmandu; Lecturer Bharat Babu Shrestha, Kathmandu; Mr. Kuber Jung Malla, Kathmandu; Dr. Surya K. Kalauni, Kathmandu and Associate Professor Akihito Takano, Machida. Let me take this opportunity to thank the higher officials of Tribhuvan University for granting me leave.

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M. B. Gewali

Chapter 1

Traditional Medical System

In a World Health Organization (WHO) document, the traditional medicine is described in the following way: “the sum total of the knowledge, skills, and practices based on the theories, beliefs and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illness” (1). With this description, it becomes apparent that the traditional medicine has wide spectrum. On one hand, it encompasses highly developed and sophisticated traditional medical systems such as the Ayurveda, the traditional Chinese medicine, the Japanese Kampo, the Tibetan medicine, the Unani and others; on the other extreme it may just plainly cover a mother’s household knowledge of curing children’s ailments such as cold and cough. In between, several other traditional systems such as folk medicine, ethnomedicine, community medicine and others fall. In some countries mostly in the western countries, several other names such as complementary, alternative, or non-conventional are also used instead of traditional medicine. People have classified the traditional medicine in different ways. Perhaps classifying the traditional medicine into Scholarly medical system, Folk medicine and Shamanistic medicine seems to be the most reasonable (2).

Scholarly medical systems are based on sound theories and principles. Behind such medical systems, there exists long, efficient and successful therapeutic history. The practitioners are produced by rigorous education and training programs. Occasional improvement and refinement on the theoretical as well as clinical aspects based on sound research and evidences are seen to have taken place in course of the development of such medical systems. Health care is provided on their own hospitals and dispensaries. The Ayurveda, the traditional Chinese medicine, the Japanese Kampo, the Unani, the Tibetan medicine all belong to this class.

Folk medicine refers to the society’s indigenous medical wisdom that is handed down generation to generation usually through oral tradition. Through the process of countless hits and trials of finding the remedies since time immemorial, the folk medicine process is deemed to have been perfected. The folk medicine may have been generated from the contribution from a particular ethnic group or from a specific locality or may have coevolved with age-old culture. Worldwide, folk medicine practices are widespread especially on the traditional societies.

Shamanistic medicine is a spiritual form of medicine where a person’s illness is believed to be caused by the spirit possession. The shaman in a trance state will communicate with spirit healers and seek remedy of the sickness. The shamanism is still practiced with gusto in different parts of the world.

Following the above classification, in the next section, concise account of the traditional medical practices found in Nepal will be described.

1.1 Scholarly Medical System

1.1.1 Ayurveda

Aurvedic medical system originated and developed in the Indian sub-continent is perhaps the oldest traditional medical system in the world having its origin in the Vedic period (ca. 1500–900 BC). The word Ayurveda is made up of two terms, *Ayus* and *Veda*. *Ayus* refers to *long life* and *Veda* to knowledge or science. Therefore, Ayurveda literally means *"science of long life"*. Two ancient Ayurvedic scriptures, the *Caraka samhita* describing internal medicine system and the *Susruta samhita* dealing with the principles and practices of surgery written in *Sanskrit* are considered fundamental pioneering texts on the Ayurvedic medicine. Agnivesa originally authored the *Caraka samhita* (1500-1000 BC). Caraka revised, modified and enlarged the *Carak samhita* (300-200 BC) which was redacted by Dridhabala (400 AD) (3). The *Susruta samhita* was penned by Susruta (1500–1000 BC) and Nagarjuna later redacted the *Susruta samhita* (400-500 AD) (4).

Ayurveda holds that the life is the amalgamation of *sarira* (body), *indriya* (sense organs), *sattva* (mind) and *atmaa* (soul). Five basic elements (*mahabhutas*) namely *prithivi* (earth), *jala* (water), *agni* (fire), *vayu* (air) and *akasa* (ether) characterize the entire universe. Everything in the universe such as man, food, medicines etc is the product of these five basic elements. *Prithivi* (earth) symbolizes the solid state of matter having stability and firmness characteristics. *Jala* (water) represents the liquid state of matter with flux or instability qualities. *Agni* (fire) brings about the conversion of the substance from solid to liquid to gas and stands for the transformation. *Vayu* (air) is the gaseous state of the matter and signifies mobility or vivacity. *Akasa* (ether) is the field without physical existence where activity takes place.

From the physiological point of view, the human body comprises of three *doshas* (humors), seven *dhatus* (tissues) and *malas* (waste products of the body) (5), (6). The *doshas* namely *vata*, *pitta* and *kapha* can effectively be described as air, fire and water respectively. These three *doshas* modulate the physiology of the human body. *Vata* functions as kinetic energy (energy of the motion) of the body. *Kapha* relates to the domain related to the potential energy (energy stored within a physical system) of the body. *Pitta* is said to balance the kinetic and potential energies of the body. These three *doshas* are responsible for deciding the *prakriti*, the constitution of the individual.

Vata is of five types from the point of view from functioning. They are *vyana* (controlling the movement of the body and inducing the circulation of blood), *udana* (creating vocal sound and inducing speech), *prana* (maintaining the breath and transmitting the swallowed food into the stomach), *samana* (digesting the food and removing the wastes from the body) and *apana* (assisting the excretion of feces, urine and ejaculation of semen).

From the perspective of functioning, *pitta* falls into five categories. They are *ranjaka* (coloring the blood and changing the nutrients into blood), *pacaka* (digesting the food), *alocaka* (producing the vision of external object), *sadhaka* (maintaining the mental

functions such as memory, intelligence and enthusiasm) and *bhrajaka* (maintaining the body temperature and providing texture to the skin).

Kapha has five domains from the consideration of functioning. They are *slesaka* (lubricating the joints), *kledaka* (moistening the food materials for digestion), *bodhaka* (generating the taste perception for the foods), *tarpaka* (helping sound functioning of the sense organs) and *avalambaka* (maintaining potency of the body).

The *dhatus* (tissues) are of seven types. They are *rasa* (nutrient fluid), *rakta* (blood), *mansa* (muscular tissue), *medas* (adipose tissue), *asthi* (bone tissue), *majja* (bone marrow) and *shukra* (semen). The *dhatus* (tissues) have dual role to play, first is to support (*dharana*) and the second is to nourish (*posana*) the body as well as the mind.

Malas represent the waste products. *Malas* are formed during the digestion of the food as well as during metabolic activities leading to the production of the *dhatus*. *Mutra* (urine), *purisa* (feces) and *sveda* (sweat) are principal metabolic wastes (*malas*). Through the medium of *srotas* (channels), the *dhatus* and *malas* are transferred to the places of requirement.

A healthy person will have the *doshas*, *dhatus* and *malas* in standard state in terms of its amount, quality and utility. When the *doshas* inside the body becomes disturbed due to external or internal factors, a person will suffer from a disease. Disease is thus result of imbalance of the *doshas*. For example, if the *agni* (fire) is disturbed, *ama* (undigested nutrients) are accumulated, the *srotas* (channels) are blocked and assimilation of the nutrients are hampered resulting in the creation of disease. In treating diseases, *dravya* (drugs) with specific *guna* (properties) and *karma* (action) inherently present in the *dravya* (drugs) are prescribed. All *dravya* (drug) is also made up of *panca mahabhutas* (earth, water, fire, air and ether). Which of these elements dominate the *dravya* (drug) decides its *guna* (properties) and *karma* (action). As everything in the universe is composed of *panca mahabhutas* (earth, water, fire, air and ether), there is no basic difference between the composition of the *dravya* (drug) and human body. Taking into consideration of the principle of similarity, a particular *dravya* (drug) with specific *guna* (properties) and *karma* (action) is prescribed in a human disease with particular symptoms. The source of *dravya* (drug) could be from the plant or animal kingdom or even from the inorganic source such as minerals and metals. The *dravya* (drug) may take the form of decoction, pills, powder, wines and oils. In Ayurveda, the diagnosis of the disease is done through the examination of pulse, urine, feces, tongue & eyes as well as by asking the patients pertinent questions.

i) Ayurveda therapy

The Ayurveda therapy is of eight types. They are briefly described below.

a) Kayachikitsa (General medicine): This treatment pertains to the diseases occurring to all organs of the body. Examples are fever, diarrhea, jaundice, anemia, liver diseases, bronchitis, hypertension, heart diseases, kidney ailments, skin diseases etc.

b) Shalya (Surgery): With major and minor surgical procedures, different diseases are cured in Ayurvedic treatment. Fistula-in-Ano, for example, is treated with the

Ksharasutra treatment. A cotton thread is impregnated with euphorbia latex followed by ash (*kshara*) of *Achyranthes aspera* and finally coated with turmeric powder. Administering the thread in the fistula wound area cures the disease.

c) Shalakya (Otorhinolaryngology and Ophthalmology): The diseases occurring above the neck such as in mouth cavity, nose, ear, eye and head come under this category.

d) Bhoot vidya (Demonology): Through the influence of gods and goddesses, demons, witches and planetary stars, people suffer from psychiatric conditions. In this treatment, such psychiatric conditions are removed with the help of *tantra manta*, blessing and animal sacrifices.

e) Kaumar bhritya (Paediatrics): This therapy takes care of children diseases, infertility, family planning and gynecological ailments.

f) Agada tantra (Toxicology): The conditions arising from the animal poisoning such as from snakebite, scorpion sting etc as well as plant and mineral poisonings are covered in this treatment.

g) Rasayan (Rejuvenation): This treatment aims for long life, prolonging youthfulness and maintaining natural beauty.

h) Vajikarana (Fertility therapy): In this category of the treatment, impotence in both male and female and other forms of sexual disorders are treated.

ii) Ayurveda in Nepal

Since time immemorial, the science of life (Ayurveda) has been a major source of health care in Nepal. Two types of Ayurvedic physicians called the *vaidya* or *kaviraj* exist in Nepal. First type belongs to those who are trained in the Ayurvedic colleges and universities. The other type includes those who learn the knowledge and skill of the profession from their father or from the *gurus* (teachers). From the very childhood, they work as an apprentice with their father or the *guru* (teacher) in the *guru-sishya* (mentor-disciple) mode and obtain the required knowledge and skill about the healing practice.

a) Ayurvedic Hospital: Under Nepal Government's Ministry of Health and Population, there are three departments and one of them is the Department of Ayurveda. Ayurveda Hospital Development Committee under the Ministry of Health and Population manages one hundred-bedded central Ayurvedic Hospital in Naradevi, Kathmandu, Nepal. This Ayurvedic hospital was established in 1933. A thirty-bedded Mid Western Regional Ayurvedic Hospital has been established in Dang in western Nepal (7). There are fourteen zonal Ayurveda dispensaries and fifty-five district health centers distributed throughout the country. More than two hundred and sixteen Ayurvedic dispensaries, district and rural pharmacies supported by the Government exist all over the nation. In addition, numerous private clinics and dispensaries are scattered all over the nation.

b) Singh Durbar Vaidya Khana: Singh Durbar Vaidya Khana (Singh Durbar Ayurveda Pharmacy) is the Government Ayurvedic medicine production unit (industry). Singh Durbar Vaidya Khana Bikas Samitee manages it (8). It has a long history. During the reign of King Pratap Malla (1641−1674), this production unit was established in the Hanuman Dhoka palace. It was shifted in a place called Thapathali by the first Rana Prime Minister Jung Bahadur Rana (1846−1856, 1857−1877). In its present place, Singh Durbar, another Rana Prime Minister Juddha Shumshere (1932−1945) installed it. In those days, the Ayurvedic medicines were meant to be produced only for the royals and courtiers. King Tribhuvan (1911−1955) is credited to have made the Singh Durbar Vaidya Khana's Ayurvedic medicines accessible to the common people at large. Singh Durbar Vaidya Khana manufactures more than hundred Ayurvedic medicines. The Ayurvedic medicines are in the form of *churna* (powder), *vati*/*gutika* (pills and tablets), *avaleha* (semisolid), *asava*/*arishta* (fermented preparations), *bhasma*/*pisti* (ash and fine powder) and *taila*/*ghrita*/*malham* (medicated oil ghee ointment). In order to prepare these Ayurvedic preparations, more than two hundred medicinal plants, around fifty minerals and animal products are required.

Herbs Production and Processing Co. Ltd., another Government undertaking based in Kathmandu is mainly involved in the production of the essential oils, herbal extracts, herbal care products and rosin & turpentine oil. Besides these Government undertakings, among some well-known private Ayurvedic medicines manufacturers include Piush Varshiya Aushdhalaya, Arogya Bhawan, Sri Krishna Aushdhalaya, Central Ayurvedic Hospital, Dabur Nepal and Gorkha Ayurved Company.



Ayurvedic Hospital in Kathmandu

c) Ayurvedic Medicine Council: Ayurvedic Medicine Council was established in accordance with Ayurvedic Medicine Council Act, 1990. This council acts as an authority to regulate and monitor the Ayurvedic education and services. It has registered Ayurvedic college graduates as its members. A different sub-committee of the council has registered Ayurvedic paramedicals. The requirements for traditional Ayurvedic practitioners trained in the *guru-sishya* (mentor-disciple) mode to be licensed are that they must be of the third generation of traditional Ayurvedic practitioners and should be of at least fifty years old.

d) Ayurveda Health Policy, 1996: With objectives to improve the health condition of the people at large and making them self-reliant on health service by exploiting huge natural medicinal resources available in the country, Ayurveda Health Policy came into existence in 1996. It has committed to improve upon qualitatively and quantitatively the Ayurveda related infrastructures such as Department of Ayurveda, central and district Ayurvedic hospitals, Singh Durbar Vaidya Khana, the Ayurvedic dispensaries and other private organizations. The policy has emphasized on herb farming, production of herbal medicines and development of herbal medicine based enterprises. Ayurvedic human resources of high quality in the fields of education, health and preparation of medicines are envisaged to be produced. The policy points out the necessity for establishing an international standard Ayurvedic research institute for doing meaningful and useful Ayurvedic researches.



An Ayurvedic Drug Store in Kathmandu

e) Ayurvedic Education: Before the advent of the formal education of the Ayurveda in Nepal, there used to be two ways of obtaining Ayurvedic education. There was century old *guru-shishya* (mentor-disciple) tradition of education. In this tradition, a student learned about the theory and practices of the Ayurveda from his father or some relative or some teacher who were well versed in the field of Ayurveda. The other way of getting Ayurvedic education was to go to places like Patna, Bananas or Calcutta in India and to get enrolled themselves in the Ayurvedic colleges. Upon completion of their education, they returned to Nepal and practiced Ayurveda.

The formal education in Ayurveda started in 1928 when *Nepal Rajakiya Ayurveda Vidyalaya* was established to produce the Ayurvedic manpower of different levels collectively called the *vaidyas*. Three courses of two years duration namely *Vaidya Binod*, *Vaidya Bhusan* and *Vidya Ratna* were offered. In around 1951, these courses names were changed into *Ayurved Madhyama*, *Ayurved Shastri* and *Ayurvedacharya*. Tribhuvan University took control of *Nepal Rajakiya Ayurveda Vidyalaya* in 1972 and it was named the Ayurveda Campus. It now offers the Bachelor of Ayurvedic Medicine and Surgery (BAMS), a five and half years long course (9). The Ayurvedic Medicine and Surgery graduates serve at zonal & district dispensaries and health centers. Two years course (after Grade 10) producing medium level work force are being provided by Nepal

Sanskrit University and Council of Technical Education and Vocational Training (CTEVT). The graduates of such courses are also providing their services as assistants in the rural area as well as in district and regional health centers & dispensaries. Formal courses leading to Doctor of Medicine and PhD are not available in Nepal. Those wishing for such degrees usually go to India.

In the following paragraph, I would like to present a short profile of a famous Nepali Ayurvedic practitioner and a few good words he spoke to me.

Dr. Kamdev Jha is a renowned seventy-six years old Ayurvedic practitioner and educator of Nepal. He started learning Ayurveda since when he was fifteen years old and completed the education at the age of thirty-nine. He received Ayurvedacharya from Sanskrit Association Bihar, Patna, India in 1956; Graduate degree in Ayurvedic Medicine and Surgery from State Faculty of Ayurvedic and Unani Medicine, Patna, India in 1959 and Doctor of Ayurvedic Medicine from Banaras Hindu University, Banaras, India in 1971. He worked as a *Hakim vaidya* (Ayurvedic doctor) in Government's district Ayurvedic health posts from 1960 to 1969. He taught at the Ayurvedic campus, Nardevi, Kathmandu for twenty-six years from 1971 to 1997. Author of several Ayurveda related publications, he was also requested to give Ayurvedic lessons in Japan, Switzerland, Germany, Mexico and USA. Dr. Jha retired in 1997. Since then, he has opened his own private clinic and dispensary at Indra Chowk, Kathmandu, Nepal. Crowds of patients waiting to be treated can be seen at his clinic.



Dr. Kamdev Jha

Dr. Jha specializes in *kayachikitsa* (general medicine). His area of interest lies on administering Ayurvedic medicine for giving childbirth of desired sex at the request of the parents. He also claims to have treated successfully diseases like AIDS and cancer. He possesses in-depth knowledge of processing herbal plant parts and minerals into the desired Ayurvedic medicines. Talking with Dr. Jha is always inspiring and educative moment. He is not happy that for a country of around twenty-seven million people, there is just one Ayurveda teaching campus, just one Government department and just one Ayurvedic central hospital. He opines that considering the activities of the ministry of health, the ministry should be renamed as medical ministry pointing to the low priority the Ayurveda in particular and other traditional medicines in general enjoy in the ministry. Dr. Jha feels uncomfortable at the group-ism mentality among the Ayurvedic personnel and cites this as one of the reasons why Ayurveda has not developed as much as it should have been in Nepal. Dr. Jha, however, sounds optimistic about the future development of Ayurveda in Nepal. He suggests that universities other than Tribhuvan University should also start programs related to teaching and research on Ayurveda. Dr. Jha calls to the Non-Governmental Organizations (NGOs) to work towards enhancing Ayurvedic health delivery systems, help utilizing medicinal plants and herbs in sustainable way and assist developing Ayurvedic medicine based enterprises.

f) Ghatte Vaidya (Funeral Doctors): In the Hindu tradition, dying in the home is not considered auspicious. Usually people prefer to breathe last on the bank of holy rivers and in front of religious temples. In Kathmandu, Aryaghat is one such holy place. Aryaghat is situated on the side of the sacred Bagmati river facing the temple of Lord Pashupatinath. When the dying person is taken to the Aryaghat, *ghatte vaidya* (funeral doctor) feels the pulse, examines the skin, eyes, breathing movement, cold and hot perspiration etc and finds out the exact day and time when the dying person will pass away. More than hundred years ago during the reign of Prime Minister Chandra Shumshere Rana (1901–1929), this tradition of *ghatte vaidya* came into existence at the Aryaghat.



Subarna Vaidya

In the following lines, I would like to profile perhaps the only *ghatte vaidya* available in the Aryaghat vicinity in Kathmandu. We would soon learn that what a remarkable social worker he is. Subarna Vaidya was born in 1949 in Devpatan, Kathmandu, Nepal. He looked much younger for his actual age of 59. He attributes this to the *yoga* and his eating habit (he eats one time a day). He comes from a well-known family of *ghatte vaidya* (funeral doctor). His father late Bharat Vaidya was a famous *ghatte vaidya* of his time. From the very childhood, Subarna Vaidya remained with his father, watched carefully the way his father practiced and learnt ins and outs of the profession. His father was in fact his *guru* (teacher). Subarna Vaidya claims that he could effectively cure kidney and liver diseases, gastric problems, diabetes, blood pressure and jaundice. He gives an example of his domestic helper who came to him with damaged kidneys. With Subarna's treatment, this domestic helper is now a healthy young man. Subarna Vaidya has been seen to be busy giving interviews and talking to the reporters. He is perhaps the most newspaper featured traditional medical worker in Nepal.

Subarna Vaidya is a recognized social worker. He established Aryaghat Sewa Kendra, a small hospital where he treats the dying patients brought to die at the Aryaghat. He gives me a figure that around 925 people from 4000 people brought to die at the Aryaghat were treated and cured by him. These men and women returned home escaping death, thanks to Subarna Vaidya. He is planning to establish such facilities in other parts of Nepal as well.

1.1.2 Homeopathy

A German physician Samuel Hahnemann (1755–1843) founded and developed the concept and theories about Homeopathy system of treatment in the eighteenth century. In this holistic medical system, forces of body, mind and emotions are thought to be constantly working to bring and maintain a state of equilibrium or balance (10). Disturbance in this balance will solicit the diseases. In Homeopathic approach, rather than to target symptoms of the diseases, the priority will be on bringing the person into right balance of body, mind and emotion. If this can be accomplished, the symptoms of

the disease will be automatically vanished. One of the basic principles on which Homeopathy is based is the Law of Similars. It tells that if a substance causes symptoms of a disease in a healthy person, small dose of that substance should cure same disease in a sick person. As an example, ipecac has been used to induce vomiting in poisoning cases. The Law of Similars will indicate that small dose of ipecac should bring to an end to vomiting. In addition, the Homeopathic medicine is subjected to extreme dilution in accordance with the Principle of Dilution. One part of the material is allowed to be diluted with ninety-nine part of the diluents such as water or alcohol. Dilution goes on until the medicine of desired therapeutic efficiency is accomplished. Because of the dilution, it is believed that on one hand, medicinal properties of the substance will be retained and on the other, side effects of the substance will be removed. Furthermore, thus prepared mixture will then be put on a process called succussion, a violent rhythmic shaking. Succussion will bring about stimulation of the latent energy hidden in the medicine.

The Government of Nepal has recognized Homeopathy treatment. The Government runs a six-bedded Sri Pashupati Homeopathic Hospital in Lalitpur, Kathmandu, Nepal. The hospital treats free of cost 200–250 patients daily. There are several private homeopathic clinics and dispensaries all over the nation.

A Homeopathic college named Nepal Homeopathy Medical College affiliated to Purubanchal University in Biratnagar has been established in 2002. This college offers bachelor level Homeopathic courses to ten students every year. One another college is said to start bachelor level Homeopathic courses in Bhaktapur in Kathmandu valley.

1.1.3 Tibetan Medicine

Known as *Sowa Rigpa* (knowledge of healing), Tibetan medicine has a long and cherished history. In the eight century, the then Emperor of Tibet Tri Song Detsen organized some sort of the medical conference inviting leading medical personnel from countries such as India, China, Nepal, Iran, Iraq and Greece. This enlightened assembly of medical doctors shared their expertise and experiences with the Tibetan counterparts. Benefiting from such discourse, the Tibetan physician Yuthok Yonten Gonpo for the first time became able to put together the main medical text, the Four Tantras. In Tibetan language, it is called the *rGyud-bZhi* (pronounced *Goo-shee*). In the following centuries, the indigenous Tibetan ideas and philosophies guided by the Budhist spirituality became hallmark in shaping the theories and practices of the Tibetan medicine. By the thirteenth century, the current version of the *rGyud-bZhi* was already prepared. Novel and innovative theoretical, clinical and herbal experiences and insights gained during the treatment process further polished the text.

Tibetan medicine considers that all living and non-living things are made up of five basic elements: earth, water, fire, air and space. Earth signifies support and mass; water denotes cohesion and liquidity; fire symbolizes heat and kinetic energy; air represents growth and movement and space embodies place where actions occur. The forces called the *Nyipa sum* govern the body physiology. Energy constantly flows in and out from the basic five elements to *Nyipa sum* and *vice versa*. To keep *Nyipa sum* in the equilibrium is the main goal of Tibetan medicine. *Nyipa sum* is of three types: *rLung*, *mKhris-pa* and *Bad-kan*.

rLung corresponds to the delicate flow of energy and resembles more with the air. *rLung* symbolizes circulation. Circulation of blood, nervous system impulses, thoughts in the mind and food on the digestive tract; expelling of feces, urine, semen & blood during menstruation as well as giving birth all fall on the domain of *rLung*. *mKhris-pa* keeps the body temperature balanced and it is connected with the element fire. *mKhris-pa* covers metabolic process, liver function and enhancing vision (11). *mKhris-pa* is responsible for the correct decision of the mind with respect to anger, aggression and hatred as well. *Bad-kan* corresponds to both earth and water. The diseases arising due to the coldness fall on the domain of *Bad-kan*. *Bad-kan* is responsible for sustaining bodily fluid, providing lubrication to the joints and for having good memorization. These three humors are interconnected to seven constituents and three modes of excretion of the body. Food (nutrition), blood, flesh, fat, bone, marrow and semen are seven constituents of the body. Three modes of excretion are through sweat, urine and feces. So long as three humors, seven body constituents and three modes of excretion are balanced, one would be in good physical and mental health. If this subtle balance is disturbed, one will fall sick. Improper eating habit, unpleasant behavior, offensive climate and manipulation by demons are thought to upset this equilibrium resulting in the manifestation of the disease.

Tibetan doctors will figure out the disturbance in *Nyipa sum* or diagnose the symptoms of the disease by three ways. First is the observation. Patient's urine and tongues are examined. Secondly, pulse reading of the patient is done. Thirdly, asking the patients about his or her past health records, food habit, the locality they live and others help the doctor to diagnose the disease. The treatment in Tibetan medicine consists of advice in diet and behavior, prescribing herbal medicines and surgery. Some other medical and surgical treatments include the massage with butter and oil mixtures, placing moxa on the selected points on the body, blood letting and cupping, saunas, taking emetics, application of golden needle therapy and heated surgical stylets.

Tibetan medicine has been in vogue in the northern part of Nepal bordering Tibet since long time. After the exile of the Dalai Lama in 1959, large number of Tibetan refugees came to Nepal. The refugees were also instrumental in promoting the traditional Tibetan healing system. Tibetan medicine is now found to be practiced in the districts such as Dolpa, Mustang, Mugu, Humla, Jumla, Manang, Surkhet, Baglung, Kaski, Gorkha, Rasuwa, Dhading, Kathmandu, Lalitpur and Solukhumbu.

Amchis are the names given to Tibetan medicine doctors or practitioners. There are several ways the *Amchis* are trained. The first way is in the traditional *guru-shisya* (mentor-disciple) mode (12). The disciple will learn both theories and practices being in close contact with the mentor. Finally, the student will be examined by the expert *Amchis* on the memorization of the important parts of *rGyud-bZhi*, his or her clinical abilities and theoretical knowledge. Furthermore, the Himalayan Amchi Association conducts refresher-training programs for the *Amchis* and *Amchi* students. One such training is one month long training on the fundamental theme of the *Chimi Gyu*, the fourth and final tantra of *rGyud-bZhi*.

In India, Lhasa and other places, there are different course of the studies as regards to the training of the *Amchis*. *Durapa* diploma is a three years course and students must have passed ten years of schooling to join this course. *Kuchapa* degree (bachelor degree) offered in India and China is a six years course including one year of in house training.

Students can join this degree course after passing grade 12 examination. *Smarampa* degree (master course) is of three years duration. *Smarampa Chewa* degree is awarded to a distinguished *Amchi* who have rendered at least twenty years of notable contribution in the fields of the Tibetan medicine research, education and clinical services.



Kunphen Tibetan Medical Center in Kathmandu

a) Himalayan Amchi Association: With the aim of preserving and consolidating the knowledge and skills represented by traditional Himalayan healers and Tibetan medicine in order to provide local communities with an effective health care system, the Himalayan Amchi Association was established in 1998 in Kathmandu, Nepal (13). Furthermore, it aspires to work towards contributing the conservation of the Himalayan ecosystems.

Tts major activities are to campaign for the recognition and support of the Tibetan medicine, to provide trainings and other forms of medical education, to put effort to provide efficient health care delivery in the communities, to work towards conservation, cultivation and sustainable utilization of medicinal plants, to undertake activities on documentation and research of the medical practices & associated knowledge and to work towards protection of intellectual property.

b) Lo Kunphen School: Lo Kunphen School is situated in Lo Monthang in the Mustang district of Nepal. The school came into existence in 2000. The school provides academic and clinical education on the traditional Tibetan medicine as well as courses on English, Tibetan, Nepali languages and mathematics. The school runs eight months courses in Lo Monthang and two months course in Pokhara

There is also a medical clinic and medicine-producing unit in Lo Monthang. Other three branches of this clinic are situated in the villages of Tsarang, Kimling and Chosher in the Upper Mustang.

1.1.4 Unani System

The Unani system of medicine has its origin in Greece. It is based on the principles put forward by the Greek physician Galen (ca. 129–216 AD). This Galenic system of medicine underwent further modification, refinement and enrichment by the

host of Arab and Persian physicians, scholars and philosophers. Consequently, this Galenic system of medicine came to be known as Unani (Arabic name for Greek) system of medicine.

Unani medicine considers disease as a natural phenomenon and symptoms are created in the body in response to the disease. Four humors like *dam* (blood) with attributes of hotness and moistness; *belgham* (phlegm) with property of coldness and moistness; *safra* (yellow bile) with qualities of hotness and dryness with and *sauda* (black bile) with features of coldness and dryness characterize the human body. As long as these four humors and associated attributes are in perfect balance or in equilibrium, a person will not suffer from disease. Disturbing this equilibrium invites the disease (14).

Diseases are diagnosed through *nabz* (pulse feeling) and urine and stool examination. *Ilaj bil tadbeer* (regimental therapy), *ilaj bil ghiza* (diet therapy), ilaj *bil dawa* (pharmacotherapy) and *jarahat* (surgery) constitute the modes of the treatments. Venesection, cupping, diaphoresis, diuresis, Turkish bath, massage, cauterization, purging, exercise, leeching are the treatment processes of the regimental therapy. Diet therapy will allow certain foods to be taken and certain foods to be avoided. Mainly herbal drugs and some drugs of animal and mineral origin are prescribed in the Unani medicine. Minor surgery are also attempted in Unani medicine.

Unani medicine has been recognized by the Government of Nepal. One Government sponsored Unani dispensary is in existence in Nepal. *Hakims* (Unani doctors) are trained in India. Upon completion of their education, they practice in Nepal although they are extremely few in number.

1.2 Folk Medicine

What is a folk medicine? Definitions and descriptions abound. One online dictionary describes the folk medicine as “treatment of ailments outside clinical medicine by remedies and simple measures based on experience and knowledge handed down from generation to generation”. Folk medicine representing traditional medical wisdom usually unwritten but orally transmitted will encompass ethnomedicine, community medicine, household medicine and any other forms of local medicines.

Folk medicine employs principles and practices sourced from the indigenous cultural development in treating symptoms of illness. Plants constitute major form of medicines in such folk medicines. A particular plant as a medicine must have been selected after countless hits and trials of treatments. Beneficial species were treasured as medicines where as non-beneficial species must have been discarded. The useful information about the plant and associated knowledge of its efficacy were thus acquired through ageless experience. Folk medicine builds an extremely close relationship with the nature or habitat from where plants are obtained. Plants in the form of medicine come from the surrounding and hence they are not alien to both of those who treat and those who are treated. Unlike the modern physician in white coat coming from unknown places, folk healers come from their own backyard and they are not some one unfamiliar. Medicines also come from their own surrounding. People thus develop a close harmony with the healers, surrounding nature as well as with the medicines.

Affordability of these folk medicines by the local people is another plus point. Majority of the people in the rural area of world are out of the reach of expensive modern treatment. For such people, folk medicines are the answer. Furthermore, by doing so, they are supporting the livelihood of their healers to some extent. Herbalists believe that these folk medicines have been time tested and therefore they have no or little side effects. This adds to the beauty of folk medicines. It is generally believed that around seventy-five to eighty percent of world population depends upon one or the other form of traditional medicine for primary heath care. In many developing societies, thus, this form of the traditional medicine is kicking and alive. Perhaps what is needed is strengthening and standardization of these practices through careful research and development.

Plants used in the folk medicines are rich source of bioactive molecules (drugs). Everybody must have taken aspirin in one time or the other for the relief of the pain. As early as in 400 BC, Hippocrates gave Greek women willow-leaf tea (the tea contained aspirin like constituent) to relieve the pain of childbirth. Quinine from cinchona bark saved life of many people from malaria. A constituent of sarpaganda (*Rauwolfia serpentina*), reserpine, was instrumental in bringing the peace of mind as well as the relief of psychotic behaviors. Periwinkle constituents, vinblastine and vincristine, were the first effective drugs against different forms of cancer. Yew tree has afforded taxol. Taxol have cured patients suffering from the breast and ovary cancers. List of successful drugs from the nature is long. Considering both flowering and non-flowering plants, around 250,000 to 500,000 plant species are believed to exist in the world. Of which, roughly 50,000 plants are believed to be used in the traditional medicine in one form or the other. One can just imagine how many medicinally useful constituents must be residing inside these 50,000 plants.

Now, let us talk about the folk medicine of Nepal. Cradled on the laps of the great Himalayas, Nepal (147181 Km^2) is a landlocked country of about 27 million people. Her rise from almost sea level to the highest point in the world is manifested in her rich and varied plant life. Nepal also boasts of having more than fifty-nine culturally rich ethnic and indigenous groups. Many of these ethnic and indigenous groups are endowed with traditional healing mechanisms and processes that are seldom written but handed down to next generation orally. Several studies have documented medicinal plants used in such time honored traditional healing mechanism as well as *modus operandi* of the healing processes. The first scientific ethnobotanical study seems to be on some edible and medicinal plants from east Nepal in 1955 (15). Several other studies then followed. Among some major studies include the ethnobotany and economy of a Khaling village (16), the high altitude ethnobotany of the Rolwalig Sherpas (17), some less known medicinal plants of Rasuwa district (18), some native medicinal plants of western Gurung (19), ethnobotanical approach to the poisonous plants of Annapurna and Langtang Himal area (20), medicinal plants used by Tharus of Dang-Deokhuri district (21), ethnobotany of the Palpa area (22), medicinal plants of Chobhar village of Kathmandu district (23), ethnobotany of Mooshar tribe of Dhanusha district (24), ethnobotany of Jumla district (25), ethnobotanical profile of Manang valley (26), ethnobotanical observation on the Tamangs of Kathmandu valley (27), traditional phytotherapy among the Sherpas of Helambu (28), ethnobotany of ceremonial plant foods of central Nepal (29), medicinal plants used by Chepang tribe of Makawanpur district (30), useful plants of Manang district (31), traditional phytotherapy of Danuwar tribe of Kamlakhonj in Sindhuli district

(32), medico-botany of Gorkha district (33), herbal folk medicines of Kabhrepalanchok district (34), uses of medicinal plants by two village communities in the central development region of Nepal (35), medicinal plant-lore of Tamang tribe in Kabhrepalanchok district (36), ethnobotany of preservation of plant foods of central Nepal (37), ethnobotany of the Tharu tribe of Chitwan district (38), herbal remedies of Surkhet district (39), medical ethnobotany in the Karnali Zone (40), folk herbal remedies of Sindhupalchok district (41), folk anthelmintic drugs of central Nepal (42), folk use of plants in veterinary medicine in central Nepal (43), herbal remedies of Surkhet district (44), medicinal plants and their traditional use by tribal people of Saptari district (45), medicinal plants of Lele Village of Lalitpur district (46), ethnobotanical note on folklore remedies of Balung district (47), ethnobotanical studies among Chitwan's Tharu (48), folk herbal medicines of Dolakha district (49), folk herbal remedies for diarrhea and dysentery in central Nepal (50), folk medicinal use of plants for respiratory complaints in central Nepal (51), medicinal ethnobotany in the Rapti zone of Nepal (52), ethnobotanical survey of herbal drugs of Kaski district (53), plants used in the treatment of domestic cattle in Narayani zone (54), folk herbal remedies for gynecological complaints in central Nepal (55), an inventory of some herbal drugs of Myagdi district (56), a survey of medicinal plants of Jajarkot district (57), folk uses of some medicinal plants of Pawannagar, Dang district (58), ethnobotanical notes on wild edible plants used by Satars of Nepal (59), ethnomedicinal uses of plants among the Limbu of Morang district (60), native phytotherapy among the Raute tribe of Dadeldhura district (61), ethnobotanical census on herbal medicine of Banke district (62), indigenous knowledge and uses of medicinal plants by local communities of the Kali Gandaki watershed area (63), medicinal plants of Dolpo (64), medicinal plant diversity and use in the highlands of Dolakha district (65), ethnobotanical notes on Thangmi plant names and their medicinal and ritual uses (66), ethnobotanical notes on the Khaptad national park (67), ethnomedicinal resources of Arghakhanchi district (68), ethnomedicinal uses of plants among the Newar community of Pharping village of Kathmandu district (69), ethnobotany and conservation of plant diversity in Nepal (70), a hand-book of medicinal plants of Nepal (71), ethnomedicine of Dolpa district (72), ethnomedicine in the Himalaya: a case study from Dolpa, Humla, Jumla and Mustang districts of Nepal (73), a compendium of medicinal plants of Nepal (74), ethnobotany of Dhading district (75), ethnomedicinal plant of Manang district (76) and use of medicinal plants in traditional Tibetan therapy system in upper Mustang, Nepal (77). Two books covering the ethnobotanical discipline in Nepal deserve mention. The first is *Ethnobotany of Nepal* written by K. R. Rajbhandari and published by Ethnobotanical Society of Nepal in 2001 (78). The book describes the local name, botanical name, taxonomic description and ethnobotanical uses of 562 plant species. The second one is *Plants and People of Nepal* by N. P. Manandhar written with the assistance of S. Manandhar and published by Timber Press Inc., Portland, Oregon, USA. (79). The book contains botanical description and traditional uses of 1517 species of higher plants from 858 genera and 195 families.

Taking cues from the above studies as well by own personal observation, one Nepali specialist has compiled the following list of the plants as folk medicines used in different physiographic zones of Nepal (80). This is not expected to be a complete list; nevertheless, it does provide a broad general picture of the status of the folk medicine in Nepal.

Folk medicines of the Terai and Siwalik Hills, up to 1000 meter

(mainly practiced by Chepang, Mooshar, Tharu, Danuwar, Satar and other communities)

Plants	Plant part used
For cuts and wounds	
Adina cardifolia	Bark juice
Aesandra butyracea	Roasted cotyledons
Ageratum conyzoides	Plant juice
Alternanthere sessilis	Plant juice
Amaranthus spinosus	Root paste
Boehmeria platyphylla	Leaf juice
Boerhaavia difussa	Plant juice
Bombax ceiba	Gum paste
Cheilanthes albomarginata	Plant paste
Cheilanthes farinosa	Pounded root
Crassocephalum crepidioides	Root paste
Crotalaria prostrata	Plant paste
Cynodon dactylon	Plant chewed
Cyperus cyperoides	Plant ash
Eupatorium adenophorum	Bud paste
Eupatorium odoratum	Leaf juice
Garuga pinnata	Bark decoction
Geniosporum coloratum	Leaf paste
Leucas indica	Plant juice
Phyllanthus reticulatus	Leaf paste
Pulicaria dysenterica	Plant paste
Solanum nigrum	Plant juice
Terminalia alata	Bark juice
Terminalia myricarpa	Bark juice
Urtica dioica	Pounded root
For pyorrhea	
Cymbopogon jwarancusa	Root juice
Used as aphrodisiac	
Elephantopus scaber	Root powder
For asthma	
Solanum surattense	Root
For throat problem	
Hemigraphis hirta	Plant juice
For body itching	
Drypetes roxburghii	Necklace of seeds

Plants	Plant part used
For gastric trouble	
Artocarpus lakoocha	Bark paste
Blumea hieracifolia	Root decoction
Cipadessa baccifera	Root juice
Cirsium wallichii	Pounded root
Cissampelos pereira	Root paste
Cynodon dactylon	Plant juice
Cyperus rotundus	Tuber paste
Desmodium confertum	Root juice
Desmodium gangeticum	Root juice
Desmodium heterocarpum	Root powder
Desmodium multiflorum	Root powder
Flemingia strobilifera	Root paste
Hedyotis scandens	Root paste
Maoutia puya	Root paste
Nephrolepis cordifolia	Tuber juice
Osbeckia nepalensis	Plant juice
Pogostemon glaber	Root juice
Sida rhombifolia	Root paste
Siegesbeckia orientalis	Root paste
Solena heterophylla	Fruit & Root paste
Vitex negando	Young leaf paste
Ziziphus mauritiana	Root juice
For fever	
Achyranthes aspera	Plant decoction
Amaranthus spinous	Root paste
Anagalis arvensis	Plant juice
Carissa carandas	Leaf decoction
Cassia fistula	Fruit pulp
Crypsinus hastatus	Root decoction
Dalbergia sissoo	Leaf paste
Equisetum debile	Root juice
Jatropha curcas	Bark juice
Langerstroemia parviflora	Leaf juice
Lippia nodiflora	Plant juice
Rauwolfia serpentina	Root juice
Ricinus communis	Young leaf
Scoparia dulcis	Root paste
Scutellaria discolor	Plant paste
Tridax procumbens	Plant juice
Spermadictyon suaveolens	Bark juice

Plants	Plant part used
For ear ache	
Cleome viscosa	Leaf
For headache	
Drymaria diandra	Plant juice
Eclipta prostrata	Seed paste
Lippia nodiflora	Plant infusion
Solanum torvum	Fruit paste
For joint ache	
Lygodium japonicum	Plant paste
Chlorophytum nepalense	Root paste
Tamarindus indica	Leaf decoction
For muscle pain	
Centella asiatica	Plant paste
For stomach ache	
Justica adhatoda	Root powder
Boerhaavia difusa	Root powder
For sprain	
Mimosa rubricaulis	Root paste
Woodfordia fruticosa	Bark decoction
For throat ache	
Fimbristylis squarrosa	Plant decoction
Spilanthes clava	Root juice
Ficus religiosa	Leaf decoction
Achyranthes aspera	Ash and stem
Desmostachya bipinnata	Root paste
Phoenix humilis	Leaf decoction
Solanum aculeatissimum	Smoke from dried fruits
Solanum surattense	Fruit chewing
Jatropha curcas	Latex
For blood vomiting	
Ipomoea quamoclit	Plant decoction
For snake bite	
Euphorbia prostrata	Plant paste
Evolvulus nummularius	Plant paste

Plants	Plant part used
For conjunctivitis	
Xanthium strumarium	Fruit
For fracture and bone dislocation	
Curcuma angustifolia	Root paste
Cymbidium aloifolium	Root paste
Dendrophthoe falcata	Fruit paste
Equisetum diffusum	Root paste
For gout	
Minosa pudica	Plant juice
For heart inflammation	
Reissantia arborea	Bark juice
For insomnia	
Solanum anguivi	Young shoot
For lactation	
Alstonia scholaris	Bark juice
Ichnocarpus frutescens	Root decoction
For leucorrhea	
Alternanthera sessilis	Plant juice
For mumps	
Cynoglossum glochidiatum	Root paste
For nocturnal discharge	
Crotalaria alata	Plant juice
For profuse menstruation	
Mirabilis jalapa	Root decoction
For sinusitis	
Lysimachia alternifolia	Leaf juice
Micromeria biflora	Plant juice
For skin cracks	
Euphorbia hirta	Plant juice
Schima wallichii	Bark juice

Plants	Plant part used
For cataract	
Coccinea grandis	Stem juice
For chapped feet	
Semecarpus anacardium	Fruit juice
For urinary trouble including calculi	
Asparagus racemosus	Infusion of roasted root
Centella asiatica	Leaf juice
Leucas cephalotus	Plant juice
For diarrhea and dysentery	
Aegle marmalos	Fruit pulp
Azadirachta indica	Gum paste
Boehmeria platyphylla	Root paste
Bombax ceiba	Resin
Cannabis sativa	Leaf powder
Centella asiatica	Leaf powder
Citrus aurantium	Fruit rind for children
Curculigo orchioides	Root
Euphorbia royleana	Milk juice
Imperata cylindrica	Root paste
Mallotus philippensis	Bark juice
Phyllanthus emblica	Fruit juice
Plumbago zeylanica	Root with other ingredients
Psidium guajava	Bark decoction
Shorea robusta	Leaf juice for children
Syzygium cumini	Bark juice
Tectaria macrodonta	Rhizome decoction
Urena lobata	Fruit paste
Xeromphis spinosa	Bark juice
Xeromphis uliginosa	Fruit paste
Zizyphus mauritiana	Plant gall powder
Used as tiny insect repellant	
Boenninghausenia albiflora	Above ground shoot
Used as tooth brush	
Jatropha curcas	Stem

Plants	Plant part used
For scabies	
Debregeasia longifolia	Leaf juice
Lyonia ovalifolia	Leaf juice
Maesa macrophylla	Fruit juice
Osbeckia stellata	Plant juice
Used as tonic	
Sida cordata	Root decoction
For burns	
Oroxylum indicum	Bark juice
Solanum tuberosum	Tuber
As anthelmintic	
Butea minor	Seed powder
Butea monosperma	Bark juice, root
Clerodendron viscosum	Buds & leaf juices
For cold and cough	
Acacia catechu	Wood decoction
Elephantopus scarber	Root chewed
Euphorbia royleana	Leaf juice
Grewia disperma	Root juice
Piper pepuloides	Fruit chewed
Pogostemon benghalensis	Root juice
Saurauia nepalensis	Fruit juice
Tridax procumbens	Flower chewed
For leprosy	
Cassia mimosoides	Plant paste
Cassia tora	Seed paste
For ringworm	
Artemisia indica	Leaf juice
For irritation	
Launea asplenifolia	Plant paste
For swelling	
Shorea robusta	Warm lead

Plants	Plant part used
For scurvy	
Mimosa pudica	Burnt leaves, seed powder
For boils, pimples and blisters	
Acacia rugata	Leaf juice
Adiantum capillus-veneris	Plant paste
Aesandra butyracea	Seed oil
Arthromeris wallichiana	Rhizome paste
Bauhinia vahlii	Pounded seeds
Chrysopogon articulatus	Root paste
Desmodium macrophyllum	Plant paste
Elatostema sessile	Plant paste
Euphorbia hirata	Plant paste
Ficus lacor	Milky latex
Mussaenda frondosa	Root juice
Phyllanthus amarus	Leaf juice
Phyllanthus reticulatus	Plant juice
Ricinus communis	Roasted seeds with mustard oil
Scoparia dulcis	Plant paste boiled in mustard oil
Sida rhombifolia	Plant ash in mustard oil
Thespesia lampas	Root paste
Tridax procumbens	Plant paste
Triumfetta rhomboides	Plant paste
Uraria lagopodioides	Plant paste heated in mustard oil

Folk medicines of the Mid Hills, 1000-3000 meter

(mainly practiced by Brahmins, Kshetri, Newar, Tamang, Gurung and other communities)

Plants	Plant part used
For gastric trouble	
Allium sativum	Garlic bulbs
Cuminum cyminum	Seed decoction
Ferula asafoetida	Latex
Piper nigrum	Fruit decoction
Zanthoxylum armatum	Fruit decoction
Zingiber officinale	Rhizome
For piles	
Rumex nepalensis	Leaves
For tooth ache	
Solanum aculeatissimum	Fruit smoke
Spilanthes calva	Chewing of flower heads

Plants	Plant part used
For body pain	
Datura stramonium	Warm fresh leaves
For headache in children	
Gentiana moorcroftiana	infusion
For sinusitis	
Hordeum vulgare	Seeds smoke
For asthma	
Justicia adhatoda	Leaf decoction
For diabetes	
Momordica charantia	Fruit decoction

Plants	Plant part used
For cuts and wounds	
Ageratum conyzoides	Leaf juuce
Artemisia dubia	Leaf juice
Cannabis sativa	Leaf juice
Centella asiatica	Plant juice
Eupatorium adenophorum	Leaf juice
Ocimum sanctum	Leaf juice
Oxalis corniculata	Plant juice
Prinsepia utilis	Seed oil
For boils, pimples and blisters	
Pinus roxburghii	Resin
For Fever	
Swertia angustifolia	Stem infusion
Swertia chirayita	Stem infusion
For cold and cough	
Brassica napus	Oil smeared
Prinsepia utilis	Oil cake paste
Trachyspermum ammi	Plant decoction
For diarrhoea and dysentery	
Amaranthus viridis	Leafy vegetable
Bombax ceiba	Dry flower decoction
Bauhinia variegata	Flowers decoction
Campylandra aurantiaca	Root paste
Ficus benghalensis	Milky juice with sugar
Foeniculum vulgare	Fried seeds with sugar
Mangifera indica	Seed paste
Woodfordia fruticosa	Dry flower decoction
Used as anthelmintic	
Butea monosperma	Seed paste
Melia azadarach	Fruit pulp
For malaria	
Swertia chirata	Stem infusion
Used as tonic	
Urtica dioica	Tender shoot
For squeezing pus from the boils or pimple	
Zea mays	Starchy paste
For flatulence	
Zingiber officinale	Fried rhizome

Plants	Plant part used
For urinary trouble including calculi	
Amaranthus spinosus	Root juice
Cucumis sativus	Ripe fruit juice
For throat and gum infection	
Acacia catechu	Wood extract
For uterus contraction	
Acacia nilotica	Gum
For headache	
Aloe vera	Leaf pulp
For expulsion of placenta after child birth	
Blumea lacera	Whole plant
For constipation	
Cassia fistula	pulp seed cover
For wet dreams and high uric acid	
Centella asiatica	Leaf juice
For squeezing pus from the boils or pimple	
Commiphora mukul	Resinous gum
Substitute of kutki	
Corydalis chaerophylla	Root
For throat infection	
Curcuma longa	Rhizome decoction
For nose bleeding	
Cynodon dactylon	Leaf juice
Used as diuretic	
Oryza sativa	Rice water
For subsiding pus formation in boils	
Pinus roxburghii	Resin
For wasp or bee stings	
Prunus cerasoides	Seed coat paste
Used as purgative	
Rhamnus virgatus	Fruits

Folk medicines of the High Mountains, 3000-5000 meter

(mainly practiced by Bhotia, Sherpa, Managis and other communities)

Plants	Plant parts used
For headache	
Gentiana capitata	Plant paste
Gentianella paludosa	Root paste
Picris hieracioides	Plant paste
Rosa sericea	Flower paste
Rubus foliolosus	Friuts
Rumex nepalensis	Root decoction
Swertia pedicellata	Root and leaf paste
Thalictrum elegans	Plant paste
For head and joint ache	
Senecio wallichii	Root paste
For back ache	
Geranium wallichianum	Plant paste
Prunella vulgaris	Plant paste
For muscular pain	
Ajuga lupulina	Plant paste
Epilobium brevifolium	Plant paste
For joint ache	
Artemisia sieversiana	Plant paste
Caragana brevispina	Plant decoction
Saussurea roylei	Plant paste
Solanum nigrum	Fruit paste
For cuts and wounds	
Adenocaulon himalaicum	Plant paste
Galium asperifolium	Plant paste
Gentianella paludosa	Root paste
Pinus roxburghii	Resin
Swertia multicaulis	Plant and root pastes
Verbascum thapsus	Plant paste
For boils, pimples and blisters	
Androsace strigillosa	Root chewed
Aretium lappa	Plant juice
Bupleurum falcatum	Plant paste
Plantago major	Plant paste

Plants	Plant parts used
For liver and chest trouble	
Equisetum diffusum	Plant paste
For profuse menstruation	
Euphrasia himalayica	Plant paste
For swelling	
Populus ciliata	Bark powder
For blood purification	
Rhododendron lepidotum	Plant paste
Used as eye tonic	
Rosa macrophylla	Fruits
For high altitude sickness	
Taraxacum officinalis	Plant paste
For ringworm	
Cynoglossum zeylanicum	Plant powder
For pelvic girdle and joint pains	
Hippophae rhamnoides	Bark and fruit paste
For fever	
Artemisia dubia	Plant paste
Cicerbita macrorrhiza	Plant powder
Gentiana robusta	Root infusion
Halenia elliptica	Root infusion
Hypericum elodeoides	Root juice
Neopicrorhiza scrophulariifolia	Rhizome and root
Megacarpoea polyandra	leaves
Prenanthes brunoniana	Flower and leaf
Pterocephalus hookeri	Root paste
For cold and cough	
Anaphalis contorta	Plant paste
Anemone rivularis	Plant paste
Clematis graveolens	Stem powder
Cotoneaster ludlowii	Ripe fruits
Heracleum nepalense	*Fried seeds*
Myricaria rosea	Plant paste

Plants	Plant parts used
For goiter	
Euphorbia wallichii	Milk juice
For gastric trouble	
Boschniakia himalaica	Plant paste
Sophora moorcroftiana	Seed paste
Vernonia anagallis-aquatica	Root decoction
For urinary trouble including calculi	
Lonicera hypoleuca	Plant paste
Malva verticillata	Plant paste

Plants	Plant parts used
For scabies	
Delphinium kamaonense	Plant decoction
For expulsion of placenta after child birth	
Dicranostigma lactucoides	Root powder
For skin diseases	
Pedicularis longiflora	Plant decoction
Trigonella gracilis	Root paste
For body pain	
Selinum tenuifolium	Rhizome paste
Thymus linearis	Plant paste

1.3 Shamanistic Medicine (Faith Healing System)

The faith healing has been described as "a method of treating diseases by prayer and exercise of faith in god". Mostly thriving on the rural and traditional societies, faith healing is still a force to reckon with in these societies. In Nepal, the faith healers are of four types: *Dhami-jhankri*, *Jharphuke*, *Pundit-Lama-Pujari-Gubhaju* and *Jyotish* (81).

In the shamanic process of healing, the disease or illness is thought to be caused by the curse of the gods and goddesses as well as by the witches, demons and other forms of evils. If a person meets a violent death such as accident, murder or suicide and the funeral rituals are not properly done, his soul will not go to the heaven or the hell. The souls roam around and are called the *pichas* (ghosts). If the *pichas* happen to touch the human, he or she is bound to become sick. The *bokshi* (witches) and for that matter *dayan* (soul of dead witches) are also believed to cause sickness in human. In addition, if a person does *kukarma* (misdeeds), he or she may be cursed with sickness by the god. When possessed by ghost, witch or any other spirit or cursed by the god, they manifest in diseases in human such as sleep disorder, loss of appetite, feeling of loneliness and sadness, headache, fever, aches and pains in different parts of the body, weakness, vomiting, hysterical and epileptic symptoms and acute stomach pain. Even the domestic animals such as cows and buffalos are rendered sick if they are possessed by the spirits.

In course of the treatment, the shaman undergoes into ecstatic trance state in such a way that soul leaves his body. The soul travels to the sky (heaven where gods and goddesses live) or deep into the earth (underworld where the demons live). The shaman in this trance state communicates with the spirit helpers to diagnose and finds cure for the illness or diseases of the patients.

a) Dhami-jhankri: *Dhami-jhakri* (82) (83) (84) is popular name of the shamans in different ethnic communities of Nepal. It appears that *jhankri* is the broad name to include shamans of all communities. However, they are known by other names as well. A Kirati shaman is called *mangpa*. Shamans are called *bijuwa* in the eastern part of Nepal.

Some other names are *ojha*, *fedangwa*, *baidang*, *phukne manche* and *janne manche*. How does a person achieve the power or the authority of the *dhami-jhankri*? There are several ways. Some of the ways are described below.

A person especially a child is kidnapped by the *ban-jhankri* (forest shaman), the mentor and doyen of all *jhankris*. *Ban-jhankris* are assumed to live in the caves high on the mountains in the forest. They indoctrinate and teach the abducted child. In course of this schooling, the child will turn into a full-fledged *jhankri*.

The second way to become a *jhankri* is to be possessed by a force of spiritual or divine spirit. Let us see an example how a person became *jhankri* (82). Person A was with his family one evening. All of sudden, person A was found to be trembling from all over his body. A village *jhankri* was called in to examine the trembling person. The *jhankri* entered into the trance and found that the person A was with gods, goddesses and spirits. Following this incident, person A was gifted with the healing power. Moreover, the village *jhankri* taught him the ritual *mantras* and other niceties of the healing practice. Person A worked as a faith healer since then.

When a *jhankri* dies, it is believed that the departed soul will not go to either heaven or to the hell. Rather it will force upon into some person's body. When this happens, the person starts trembling and soon enters into trance. Subsequently, the person is rewarded with the healing power and he becomes a new *jhankri*. After hundred years, when the soul is changed in several *jhankris*, the soul is converted into god. Thus formed god is known as *Bhayer deuta* (Bhayer god).



Dhami-Jhankris

Faith healing can be learnt in *guru-shisya* (mentor-disciple) mode of education as well. After rigorous apprenticeship of several years, the disciples will be graduated into working *jhankris*. Some are born *jhankris*. Upon birth, these people are delegated with the healing power. To refine and fine-tune their healing abilities, they would have local *jhankri* as their mentor (*guru*).

A brief description of the *jhankri* ritual is as follows. The *jhankri* will first try to uncover what is the nature of the disease, what caused it and the psychology of the patient by doing *jokhana* (oracle). Some objects such as ginger roots or rice grains are tossed up either on the brass plate or on the surface of the drum. The way they settle down will indicate about the disease and its causes. The *jhankri*'s usual accessories for the treatment are a *dhyangro* (a musical drum) and a broom called *chamer*. Some herbs

are burned and smokes are created. Chanting the sacred *mantras* handed down since ages, playing the *dhyangro* and cleaning the patient's body from the evil spirit with the broom, the *jhankri* in euphoric manner travels into trance state where he communicates with god, goddess or spirit for the safe recovery of the patients. For curing the patient, the *jhankri* pledges to worship these deities. Birds such as roosters and ducks or even goats are sacrificed to satisfy the deities. In order to make sure that the spirit is thrown out from the patient's body, at times the patients are beaten or are touched by red-hot iron or even suffocated with water. The *jhankris* claim that the patient will feel no pain.



Som Prasad Nepal (Sambhu)

b) Jharphuke (Sweeping and blowing healers): They also constitute spiritual healers; however, they lack the power of undergoing into trance. They use *jharphuk* (sweeping and blowing) for the diagnosis and treatment of the ailments. By murmuring *mantras* and touching & blowing the patients over the effected area, the *jharphuke* cures the patients. At times, they give herbal medicines prepared by themselves to the patients.

Let us learn about a *jharphuke* who was born in the eastern Nepal and is now busy practicing in Baneswor, Kathmandu, Nepal. Fifty-five years old Som Prasad Nepal (Sambhu) is a popular *jhar-phuke*. When he was seven years old, he became a *pujari* (priest) at Siddha Kali Mai Temple at Bhojpur in eastern Nepal. At the age of nine, he was endowed with the power of *jhar-phuk* (sweeping and blowing) through the grace of Sidha Kali Mai. In course of time, he also self learnt *jyotishi* (astrology) and Ayurveda. He claims that his specialty lies on the treatment of jaundice, syphilis, menstruation problems, nerve and mental diseases. He prepares the medicine by himself. One of his areas of expertise is to treat the women who could not bear the baby. He claims that in Bhojpur, out of forty-two women he treated, forty successfully gave birth. Since last five years, he lives and practices at Baneswor, Kathmandu, Nepal. Around 25–40 patients daily visit him. When asked what measure should be taken to popularize *jhar-phuk* (sweeping and blowing) therapy, Som Prasad Nepal immediately responded that usefulness of *jhar-phuk* therapy needs to be taken to the wider section of the society through the medium of television, radio and newspapers.

c) Pundit-Lama-Pujari-Gubhaju: *Pundit*, *Lama*, *Pujari* and *Gubhaju* are all priests. *Gubhaju* are the priests of the Buddhist *Newars*, *Newars* being the original inhabitants of Kathmandu valley. *Lamas* are the Buddhist scholars and are the priests at Buddhist monasteries. *Pundit* and *Pujari* are Hindu priests. They all diagnose and cure illness through prayers and rituals. This type of the treatment is called ceremonial healing. In *Newar* communities, when a woman is possessed by the deity *Harati*, she would be called *Deo-ma* (literally meaning "Goddess mother"). *Deo-ma* is known to heal diseases, tame witches and chase away wicked spirits. If some thing is stolen, in a process called "*veer dekhaune*", the *Deo-ma* would bring the picture of the thief on the nail of the person whose item has been stolen and the thief thus will be identified.

d) Jyotish (Astrologers): *Jyotish* are also Hindu priests. They read the horoscope, palm and fore head of the patients. They interpret the influences of the planets on the patients. By doing so, the illness of the patient will be diagnosed. In order to reduce or mitigate the illness, various remedies are prescribed. Remedies take the form of chanting vedic prayers (*mantras*), putting on gem stones (*ratna*), fasting on particular days (*upavash*), wearing amulets (*yantras*), donating to the poor and deprived (*daan*), carrying out fire rituals (*yajnas*), offering selfless service (*shewa*) etc.

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Chapter 2

Medicinal Plants

Sandwiched between two Asian giants, India on the south and China on the north, Nepal (147,181 Km^2) lies on the central region of the great Himalayan range. Her altitudinal variation starting from almost sea level (~ 70 meter) to the top of the world (8,848 meter), climatic differences, varied topography and abundant ecological habitats offer rich flora and fauna life. The prosperous biodiversity of the living organisms has thrived inside the country. The country is endowed with four physiographic zones; lowlands, mid-hills, high mountains and high Himalayan range (1). The characteristics such as the elevation, surface area and climatic conditions of these physiographic zones are presented in the table below.

Physiographic Zones of Nepal

Physiographic zone	Surface area (%)	Elevation (m)	Climate
High Himal	23	above 5,000	Tundra-type and Arctic
High Mountains	20	4,000 – 5,000	Alpine
		3,000 – 4,000	Sub-alpine
Mid-hills	30	2,000 – 3,000	Cool temperate monsoon
		1,000 – 2,000	Warm temperate monsoon
Lowlands (Terai and Siwalik Hills)	27	500 – 1,000	Hot monsoon and Subtropical
		below 500	Hot monsoon and Tropical

Nepal has been described as having 118 ecosystems of which the Terai region contains 10, Siwalik hills 13, mid-hills 13, highlands 38 and others 5 (2). Forest accounts for about 29% of the total land area. Let us see in the following table floral species distribution in the physiographic zones of the country (3).

Number of Flora Species in Physiographic Zones

Plant types	Terai and Siwalik hills 1,000 m	Mid-hills 1,000-3,000 m	High-hills >3,000 m
Bryophytes (liverworts, mosses)	61	493	347
Pteridophytes (ferns)	81	272	78
Gymnosperms (naked seed plants)	–	16	10
Angiosperms (flowering plants)	1,885	3,364	> 2,000

Mid-hills (1,000–3,000 meter) are thus are found to possess highest-level diversity of plant species, although other regions are also not far behind. About 246 flowering plant

species are endemic to Nepal (4). High altitude places (mostly alpine and sub-alpine regions) have the lion share of the endemic plants. These regions possesss around 131 endemic plants. Let us now be familiar with the dominant plant species in these physiographic zones (5), (6).

a) Tropical zone (below 1000 meter): Tropical zone consists of two regions- Terai and the Siwalik hills. *Shorea robusta* (sal) is the dominant tree of the entire Terai region. The other trees found in the *Shorea robusta* forest include *Adina cordifolia*, *Aegle marmelos, Anthocephalus chinensis*, *Albizia* spp., *Anogeissus latifolia, Butea frondosa*, *Dillenia pentagyna* and *Dillenia indica*. Because of soil, rainfall and climate, the vegetation pattern of western and eastern Terai are different. Eastern Terai possess *Cycas pectinata, Gnetum montanum, Calamus* spp.*, Cythea spinulosa, Pandanus nepalensis* and the grassland called *phanta* in vernacular. Western Terai has abundant quantity of *Pinus roxburghii*. Places where *Shorea robusta* are in small number or all together missing, *Lagerstroemia parviflora*, *Garuga pinnata*, *Mitragyna parvifolia, Schleichera oleosa, Terminalia bellirica, Terminalia chebula*, *Terminalia alata, Holarrhena pubescens* and *Mallotus philippensis* are found. In the riverine forests, *Acacia catechu*, *Dalbergia sissoo*, *Dalbergia latifolia*, *Syzygium jambos*, *Eugenia operculata* dominate. Other trees available in the tropical region are *Albizia procera*, *Alstonia scholaris*, *Bombax ceiba*, *Bridelia retusa*, *Callicarpa arborea*, *Dillenia indica*, *Ficus* spp., *Kydia calicyna*, *Lannea coromandalica, Macaranga denticulata, Oroxylum indicum* and *Semecarpus anacardium*. In the Siwalik area, *Cycas pectinata, Gnetum montanum, Duabanga grandiflora, Calamus s*pp.*, Cythea pinulosa, Pandanus nepalensis* and *Podocarpus neriifolius* are obtained.

b) Subtropical Zone (1,000 to 2,000 meter): *Pinus roxburghii* forests are found in the drier regions. In more humid regions, *Schima wallichii*, *Castanopsis indica* and *Castenopsis tribuloides* dominate the sub-tropical forests. In other types of forests, *Castanopsis tribuloirdes* forest mixed with *Schima wallichi, Rhododendron* spp*., Lyonia ovalifolia, Eurya acuminata* and *Quercus glauca*; *Schima wallichii*- *Castanopsis indica* hygrophile forest; *Schima-Pinus* forest; *Pinus roxburghii* forest together with *Phyllanthus emblica*, *Semecarpus anacardium*, *Rhododendron arboreum* and *Lyoma ovalifolia*; *Schima- Lagerstroemia parviflora* forest; *Quercus lamellosa* forest with *Quercus lanata* and *Quercus glauca*; *Castononpsis* forest with *Castononpsis hystrix* and Lauraceae family species; mesohygophyllus forest with *Quercus galuca* and *Quercus lanata* are available in subtropical zone. Mixed broad-leaved forests with the laurels such as *Litsea* spp*., Enlistee cupola*, *Persia odoratissima*, *Persea duthiei* mixed with *Engelhardtia spicata, Rhododendron arboreum, Lyonia ovalifolia, Pyrus pashia, Rhus* spp*., Acer oblongum, Myrica esculenta, Michelia kisopa,* and *Betula alnoides* are also available. Other plant species common in the subtropical forests are *Cretaeava unilocularis, Trewia nudiflora, Premna interrupta*, *Ulmus lancifolia*, *Ulmus chumlia, Glochidium velutinum*, *Callicarpa arborea, Toona ciliata, Ficus* spp*., Mahosama similicifolia, Trevesia palmata, Xylosma longifolium, Boehmeria rugulosa, Scheffera venulosa, Michelia* spp., *Casearia graveolens*, *Rhus wallichii, Actinodaphne reticulata, Sapimum insegne, Alnus nepalensis*, *Ardisia thyrsiflora, Ilex* spp., *Macaranga pustulata, Trichilia cannoroides, Celtis tetranda, Wenlendia puberula, Saurauia nepalensis, Ligustrum confusum, Zizyphus incurva, Camellia kissi, Hymenodictyon flaccidum, Maytenus thomsonii, Zanthoxylum*

armatum, Rhus succednea, Eurya acuminata, *Myrsine semiserrata, Sloanea tomentosa, Symplocus* spp., *Cleyrea* spp. and *Hydrangea aspera*.

c) Temperate Zone (2000-3000 meter): In the central and eastern Nepal especially in south facing slopes, there exist broadleaved evergreen *Quercus lamellosa* and *Quercus semecarpifolia* forests. Other plant species found in such forests include *Lindera* spp., *Litsea* spp., *Tsuga dumosa, Rhododendron* spp., *Magnolia campbellii, Michelia doltsopa*, *Pieris ovalifolia, Daphnephyllum himalayanse*, *Acer campbellii*, *Acer pectinatum* and *Sorbus cuspidata*. Other forest types found in the temperate zones are *Rhododendron arboreum*, *Rhododendron barbatum*, *Lyonia* spp., *Pieris formosa*; *Tsuga dumosa* forest with such deciduous species as *Acer* and *Magnolia*; deciduous mixed broadleaved forest of *Acer campbellii*, *Acer pectinatum*, *Sorbus cuspidata*, and *Magnolia campbellii*; mixed broadleaved forest of *Rhododendron arboreum*, *Acer campbellii*, *Symplocos ramosissima* and Lauraceae species. Other important plant species found in this region include *Abies pindrow, Betula utilis*, *Buxus rugulosa*, *Benthamidia capitata, Corylus ferox*, *Deutzia staminea*, *Euonymus tingens*, *Abies spectabilis*, *Acanthopanax cissifolius, Coriaria terminalis, Fraxinus macrantha, Dodecadenia grandiflora, Eurya cerasifolia*, *Hydrangea heteromala, Ilex dipyrena*, *Ligrestum* spp., *Litsea elongata*, *Juglans regia*, *Michelia doltsopa*, *Myrsine capitallata, Neolitsea umbrosa, Philadelphus tomentosus, Osmanthus fragrans, Prunus cornuta, Rhododendron campanulatum* and *Vibernum continifolium*.

d) Sub-alpine Zone (3000-4000 meter): The major forests of the sub-alpine zones belong to *Abies spectabilis*, *Betula utilis* and *Rhododendron* spp. Many valuable medicinal plant species belonging to *Aconitum*, *Allium*, *Bergenia*, *Ephedra, Betula*, *Paris*, *Neopicrorhiza, Swertia* and *Taxus* are available in the sub-alpine region. Other plant species of importance found in the sub-alpine zone are *Sorbus cuspidata*, *Euonymus tingens*, *Ribis glaciale*, *Acer pectinatum*, *Salix* spp., *Lyonia* spp., *Prunus rufa*, *Acer candatum*, *Acanthopanax cessifloia*, *Sorbus microphylla*, *Berberis* spp. and *Juniperus* spp.

e) Alpine Zone (above 4000 meter): Alpine vegetation contains stunted bushy shrubs. The major plant species are *Rhododendron anthopogon*, *Rhododendron lepidotum*, *Juniperus recurva*, *Juniperus indica*, *Juniperus communis* together with *Ephedra gerardiana*, *Berberis* spp. and *Cotoneaster accuminata*. In the river valleys, *Hippophae* spp., *Salix* spp., *Saxifraga* spp., *Arenaria* spp. and *Androsace* spp. and alpine grasses are available. Alpine zone also contains herbal resources such as *Primula* spp., *Gentiana* spp., *Corydalis* spp. and *Saussurea* spp. Beyond around 5200 meter, there remains snow all around the year and only mosses and lichens are found here and there. The plant life is nonexistent generally above 6000 meter in the nival zone and artic desert. At one instance plant life has been detected in as high as 6100 meter, the plant species being *Stellaria decumbens* and *Parrya lanuginosa*.

2.1 How Many Medicinal plants?

Firstly, what constitutes a medicinal plant? A medicinal plant is any plant used in order to relieve, prevent or cure a disease or to alter physiological and pathological process or any plant employed as a source of drugs or their precursors (7). There is another term often associated with medicinal plant: aromatic plant. A plant with elevated level of volatile oil (called essential oil) is an aromatic plant. Essential oils in addition to being medicinal have immense economic value. They find wide applications in flavors, fragrances and perfumes. When was the medicinal herb first used? This should come as a tough question and is difficult to answer. In the personal belongings of an "ice man" frozen in the Swiss Alps for more than 5,000 years ago, medicinal herbs apparently to treat for intestinal parasites are reported to have been found (8). Therefore, the only thing we can safely say is that the history of the utilization of the medicinal plant is very long. Nepal is believed to possess around 7000 vascular plant species. How many of these plants are medicinal is difficult to ascertain. Moreover, it is not surprising. First, to have a sound inventory list of the medicinal plants and herbs is arduous job. It is also not unexpected that each new expedition would find plants of new traditional uses. In 1970, Nepal Government's Department of Plant Resources (then known as Department of Medicinal Plants) published the first detailed survey of the medicinal plants found in Nepal and the number of the medicinal and aromatic plant species was estimated to be 483 (9). The medicinal and aromatic plant data base of Nepal (MAPDON) puts the number of the medicinal and aromatic plants in the wild, cultivated, imported and naturalized found in Nepal as 1624 (10). A more recent publication records the number of the medicinal and aromatic plants found in Nepal as high as 1792 (11). In between, there are some other studies pointing to different numbers of the medicinal and aromatic plants in the country. Similarly, one such study gives the following percentage breakdown of the distribution of the medicinal and aromatic plants available in physiographic regions of the country (12).

Distribution of the Medicinal and Aromatic Plants (MAPs) in Physiographic Zones

Region	% of MAPS available
Alpine region above 4000 m	7
Sub-alpine region 3000 – 4000 m	18
Temperate region 2000 – 3000 m	36
Sub-tropical region 1000 – 2000 m	54
Tropical region above 1000 m	49

As seen from the above table, the sub-tropical and tropical regions possess highest share of the medicinal and aromatic plants followed by the temperate, sub-alpine and alpine zones. The medicinal plants belonging to the sub-alpine and alpine regions are prized for their high medicinal utilities as well as their export potentialities. In these areas, these medicinal plants and herbs offer the subsistence income for the poor and marginalized people well as the revenues from their collection to the Government.

How many plants are used medicinally worldwide is again not easy to determine. For that matter, people just have vague idea about how many plant species the world hosts. The total number of the plant species on the earth is believed to be in the order of around 250, 000 to 500,000. A general breakdown of the medicinal plants available in selected countries has been estimated in an article (13) and is given below in a table.

Number of Medicinal Plants in Selected Countries

Country	Higher plant species	Medicinal plant species	%
China	26092	4941	18.9
India	15000	3000	20
Indonesia	22500	1000	4.4
Malaysia	15500	1200	7.7
Nepal	6973	700	10
Pakistan	4950	300	6.1
Philippines	8931	850	9.5
Sri Lanka	3314	550	16.6
Thailand	11625	1800	15.5
USA	21641	2564	11.8
Viet Nam	10500	1800	17.1

As shown in the table, out of China's 26092 plant species, 4941 plant (18.9%) species contain medicinal properties. India is shown to possess 15000 plants species. Of which, 3,000 (20%) are medicinal plants. In case of Nepal, in this table, the number of the medicinal plants is shown to be 700 (10%) out of total 6973 plants species.

2.2 Why Medicinal Plants?

Indian sub-continent is the home of perhaps the oldest scholarly traditional medical system called Ayurveda. Nepal does have long tradition of Ayurvedic medical practice. Aside from Ayurveda, there are other important traditional medical systems such as Unani, Homeopathy and Tibetan medicine for health care delivery of the common people. Plants form the primary bulk of medicines in such traditional medical systems. In Ayurveda, around 1250–1400 plant species are used in the preparation of the medicines. Continuous supply of the medicinal plants is crucial for manufacture of the medicines in such systems. High Himalayas to low Terai region have been contributing useful plants to such traditional medicinal systems since time immemorial.

Nepal is home to more than 59 culturally rich ethnic and indigenous groups. Many of them have their own medical practices handed them orally from generation to generation. As in the scholarly traditional medical systems, plants form the mainstay of the folk medicine. In fact, the folk medicine employs more number of the plants than the plants used in the scholarly medical systems. One approximation puts that up to 70-80% of the rural population of Asia use medicinal plants for their primary health care. To

sustain and perpetuate folk medicine systems to provide primary health care for the majority of inhabitants in the rural area, medicinal plants are bound to play pivotal role.

Harvesting and gathering of the medicinal and aromatic plants provide subsistence living income for many in the remote rural area. They usually are deprived section of the society such as landless poor, indigenous groups and the women. An improved sustainable medicinal plants management is expected to make their life little easier and better. Furthermore, substantial volume of medicinal and aromatic plant trade occurs from Nepal to other countries especially to India. Herbal craze in the developed countries are developing day by day. Herbal teas, herbal soaps, herbal shampoos and herbal creams are so much in demand in the western societies. One can easily expect that the international demand for Nepali herbs will enlarge with passing of time. Because of this, the medicinal and aromatic plants business is bound to play a significant role in the national economy as well. It is usually argued that the conservation and sustainable use of the medicinal plants will bring about the conservation of each member of the ecosystem. The motivation to ensure sustainable use of the medicinal plants will pass benefit to the other plant species in the habitat as well.

2.3 Medicinal Plants of National Priority

Based on the criteria such as national and international commercial demand, geographical range of distribution, local use and inherent medicinal properties, Nepal Government has recognized thirty medicinal plant species as the national priority herbs for their development, research and cultivation (14). The names of these thirty plants are given in the following table.

National Priority Herbs

	Plants	Local name		Plants	Local name
1	*Dactylorhiza hatagirea*	Panchaunle	16	*Aconitum spicatum*	Bisjara
2	*Neopicrorhiza scrophularifolia*	Kutki	17	*Podophyllum hexandrum*	Laghupatra
3	*Nardostachys grandiflora*	Jatamansi	18	*Bergenia ciliata*	Pakhanbed
4	*Valeriana jatamansii*	Sugandhawal	19	*Piper longum*	Pipla
5	*Swertia chirayita*	Chiraito	20	Lichens	Jhyau
6	*Rauwolfia serpentina*	Sarpagandha	21	*Rheum australe*	Padamchal
7	*Cordyceps sinensis*	Yarshagumba	22	*Rubia manjith*	Majitho
8	*Taxus wallichiana*	Lauth salla	23	*Cinnamomum glaucescens*	Sugandha kokila
9	*Zanthoxylum armatum*	Timur	24	*Aconitum heterophyllum*	Atis
10	*Asparagus racemosus*	Satawari	25	*Juglans regia*	Okhar
11	*Gaultheria fragrantissima*	Dhasingre	26	*Azadirachta indica*	Neem
12	*Acorus calamus*	Bojho	27	*Dioscorea deltoidea*	Bhyakur
13	*Cinnamomum tamala*	Tejpat	28	*Morchella conica*	Gucchi chyau
14	*Sapindus mukorossi*	Ritha	29	*Tegetes minuta*	Ban sayapatri
15	*Tinospora sinensis*	Gurju	30	*Phyllanthus emblica*	Amla

2.4 Biodiversity

Biodiversity has many definitions and descriptions. A simple meaning of biodiversity will amount to "variation of life at all levels of biological organizations". The 1992 United Nations Earth Summit in Rio de Janeiro defined biodiversity as "the variability among living organisms from all sources, terrestrial, marine and other aquatic ecosystems as well as the ecological complexes of which they are part". It thus includes diversity within species, between species and of ecosystems. How many species of plants and animal are there on the earth? Nobody exactly knows. There is a speculation that the number of plant and animal species is somewhere between 2 to 50 million. How many of these have been identified? Again, a rough estimate is that any where between 1.5 to 1.8 million species have been identified (15). Biodiversity brings direct benefits to the mankind in the form of food, medicinal and pharmaceutical resources, timber, ornamental plants and animals, wild life viewing, ecotourism to name a few. It also provides ecosystem services such as nutrient cycling, water purification, climate regulation, soil formation and protection and maintenance of ecosystem etc. Medicinal and aromatic plant is a component of biodiversity. So long as biodiversity is undamaged, medicinal plant remains intact. However, this has not remained the case always.

2.4.1 Biodiversity Depletion

Natural resources are being depleted at alarming rate. What are the culprits for this? In most cases, man's deeds or may be the better word would be misdeeds are responsible for sorry state of the biodiversity. Worldwide, the following are the main causes for the depletion of the biodiversity (a) habitat loss and fragmentation (b), utilization of the natural habitat for industrial, agricultural and mining purposes (c), overexploitation of living organisms (d), pollution of soil, water and air (e), introduced alien species and (f) scarcity of pollinating vectors. A Nepali expert enumerates the following principal threats for the conservation of biodiversity in Nepal (16).

a) Deforestation: Historically the tropical hardwood has been the item of the natural resource based trade in Nepal. Traditional energy, which account for 85.27% of the total energy consumption in the country mainly consists of fuel woods in addition to agricultural residues and animal dung. Developmental activities such as construction of roads, dams, canals, high-tension electricity lines together with conversion of forest to arable land, excessive gathering of timber for domestic use and commercial logging have taken toll on the forests. Consequently, a substantial number of plant species are put into risk of being depleted.

b) Forest fire: Fire is deliberately set in the forests in order to get fuel wood, coal and construction materials. Forest fire also helps extending the adjacent agricultural land. To increase the growth and yield of expensive morel mushrooms such as *Morchella conica*, high altitude pine forests are found to be burned. Pasturelands are put into flame to obtain tender grasses. By doing such practices, the herbs growing in the area are likely to be affected. Not only the roots and rhizomes of the herbs are destroyed, even small shrubs and lower branches of the trees remain damaged. The fire is also said to contribute for

damaging alpine butterfly in quite a number whose larvae ultimately host to produce well-known *yarshagumba* (*Cordyceps sinensis*). Fire depletes organic upper layer of the soil which is required by many species to thrive. In addition, the wildlife such as mammals, birds, reptiles, insects suffer irreparable loss from the fire.

c) Shifting cultivation: Shifting cultivation consists in clearing and burning of a scrap of forest for agriculture purpose. After the land is used, this land is abandoned and a new forest patch is cleared and burned. This practice destroys valuable forest species. Furthermore, abandoned land will be succeeded by fewer and quite different species.

d) Overgrazing: Forest and pasturelands have been providing fodder and other feeding materials to the cattle, yaks, sheep, goats and others. Heavy grazing of forests and pasturelands in the mountains has detrimental effect on land productivity as well as the surrounding biodiversity.

e) Overharvesting: The non-timber forest products (NTFPs) especially the medicinal and aromatic plants have been subjected to excessive harvesting over the years. It is alleged that the harvesters and the village traders alike are more driven to short-term profit than respect for sustainability of the herbs they are extracting. Because the contracts are for a fixed amount of time, the contractors might like to collect as much as possible keeping no concern for its long-term repercussion. The collectors or harvesters are expected to maximize their income by collecting the forest products as much as they can. The collectors are at times found not equipped with the knowledge for sustainable harvesting of the medicinal and aromatic plants. Their collection methods at times seem to be damaging for the further survival of the plant species. When the collectors do not have the ownership over the collected resources, they care less for the continuity of the natural resources.

In addition to the above-mentioned anthropogenic causes for the depletion of the biodiversity and habitats, natural causes such as landslides in the mountainous regions, floods as well as the effect of the global warming such as retreat of the glaciers and increase in the use of synthetic pesticides and herbicides are also contributing towards the loss of biodiversity.

2.5 Conservation of the Medicinal Plants

Medicinal and aromatic plants have both domestic and international markets. Excessive trading may lead to its diminished availability or even altogether its disappearance. Therefore, issue of conservation of the medicinal and aromatic plants becomes apparent when its trade endangers the survival of the species or seriously erodes genetic diversity of the species or threatens the survival or functional integrity of natural or semi-natural ecosystem or is unsustainable which means the species is extracted from a particular site at a rate greater than at which it is replaced (17). When people talk about over harvesting of the species leading to its destruction or near destruction, cases of two plants come to the mind, silphion and *Prunus africana*. Silphion belonging to genus Ferula grew in northern African dry mountains facing the Mediterranean Sea during the seventh century (18). The plant possessed contraceptive and abortive properties. Silphion was so popular

that it even featured in the ancient coins. Silphion's high demand and utilization in the middle east in those times led to excessive harvesting of the plant. As a result of which, sadly silphion was put into extinction. Another plant of near destruction was *Prunus africana* (19). *Prunus africana* was a valued African traditional medicine for the treatment of chest pain, malaria and fever. However, its utility was more realized in Europe where it was used to treat prostrate gland hypertrophy (enlarged prostate gland) as well as benign prostatic hyperplasia. The plant was subjected to massive commercial exploitation since 1972. Its bark extract in form of the capsules were sold in various names in Europe such as pygenil in Italy and tadenan in France. One tree contains about 75 kg of the bark. To get 5 kg of the extract one needed 2000 kg of fresh bark. From Cameroon alone, 1.5 million kg of bark in the 1980s and 2 million in early 1990s were exported. One estimate puts its bark and extracts global demand as 2.45 million kg in 1995, 2.78 million kg in 1996 and 3.91 million kg in 1997. This scale of commercial exploitation and unsustainable harvesting almost wiped out its existence as a genetic entity. In 1995, *Prunus africana* was included in Appendix II of the Convention on Trade in Endangered Species (CITES). Inclusion in Appendix II meant that its harvesting had to be sustainable as well as its import and export needed be declared. Afterwards, small-scale cultivation of the plant started.

2.5.1 Conservation Strategies

What should be the ways for sustainable utilization of medicinal plant resources? Four types of conservation strategies have been suggested (17). They are sustainable harvesting of a non-cultivated plant; *in situ* conservation of germplasm of a medicinal plant species; *ex situ* conservation of germplasm of a medicinal plant species and transfer of commercial supply of a species to cultivation.

a) Sustainable harvesting of a non-cultivated plant: Firstly, the prevailing harvesting method of the particular wild species of the medicinal plant needs to be clearly evaluated. It is imperative to examine the impact of harvesting on this wild population of species of the medicinal plant as well as on the broad biodiversity of which the plant is a member. The role and position (economic, political and social) of the actors of the harvesting process such as the collectors, middle men and traders as well as the community where the harvesting takes place are important to understand for the sustainability of the species. If the species is found to be threatened, new process of harvesting is to be tried out taking into consideration of socioeconomic status of the harvesting area. The community will have to have upper hand in the new process as well. The change will have to be attempted on trial basis. Should it prove to be successful, sustainability in harvesting will be achieved taking into account of both biological as well as socioeconomic realities.

b) In situ conservation of germplasm of a medicinal plant species: In the harvesting area, the population of the plant species in question as well as the genetic diversity pattern needs to be ascertained. In order to maintain viable population of desired species in the habitat, necessary management needs are sought. Who will take in charge of management process will have to be identified. Awareness campaigns as to the

importance of the conservation process as well as desirability of sustaining of the plant species should be initiated. This would have repercussion on developing and enforcing CITES regulation. This whole process will culminate hopefully in well-managed protection and sustainable use of the plant species of desire.

c) Ex situ conservation of germplasm of a medicinal plant species: In order to plant desired medicinal plant species outside its habitat, viable methods of its propagation and multiplication are to be sought. Should this prove to be successful, it will ensure the availability of adequate quantity of the plant materials for reintroduction in different setting as well as for the commercial cultivation.

d) Transfer of commercial supply of a species to cultivation: A good and promising cultivar of the plant species is chosen. Reliable techniques for its propagation, cultivation, harvesting, storage and marketing are to be figured out. Then, the cultivar is taken to a suitable potential grower. It should be made sure that new cultivar cultivates and propagates in new environment. Cultivation of the plant species will hopefully reduce the wild collection of the plant making wild varieties of the plant less threatened. A steady income from the cultivated plant to the rural communities will be forthcoming.

2.5.2 Benefits of Medicinal Plant Cultivation

There are several benefits associated with commercial medicinal plant cultivation (20). These include

a) conserving endangered species: Needless to write that there are several wild species that have been subjected to extensive exploitation for their role as therapeutic agents are deemed endangered. Cultivation of such plants will reduce the pressure on the wild.

b) production of uniform material: Improved cultivars or selected clones when cultivated are expected to produce uniform material. This would ensure production of medicinal and aromatic plants with consistent and hopefully high quality properties. Not only this, large amount of the material abound ensuring continued supply of the medicinal plant. In addition, medicinal plants can be stored for longer period.

c) providing good income to the farmers: If improved high yielding cultivars are used in the cultivation, the farmers are expected to obtain higher income. Furthermore, there is likelihood of creating new employment opportunities.

d) providing opportunities for value addition through processing: If consistently high quality species are obtained in reasonable quantities, there is always possibility of establishing processing units in the cultivation area thereby producing value added products. An example will be the setting up of the distillation plant in essential oil bearing plants cultivated area. With these advantages in hand, one would expect that the medicinal plant cultivation would be readily accepted by the farmers. However, this is not quite happening. Then the question is why. Farmers view medicinal plant cultivation as high-risk activity. Individual land holding is small and farmers are unwilling to use all the land for medicinal plant cultivation purpose. At the best, they will use small portion of

their land. As opposed to their usual crops, medicinal plants usually take longer period for harvesting and the farmers are found reluctant to wait for such a long time. The return from the medicinal plant cultivation is perceived as not adequate in view of the intricacies and uncertainty involved in the medicinal plant cultivation. The low price of the cultivated medicinal plant could result from ongoing low cost collection from the wild as well as lower bargaining capacity of the farmers.

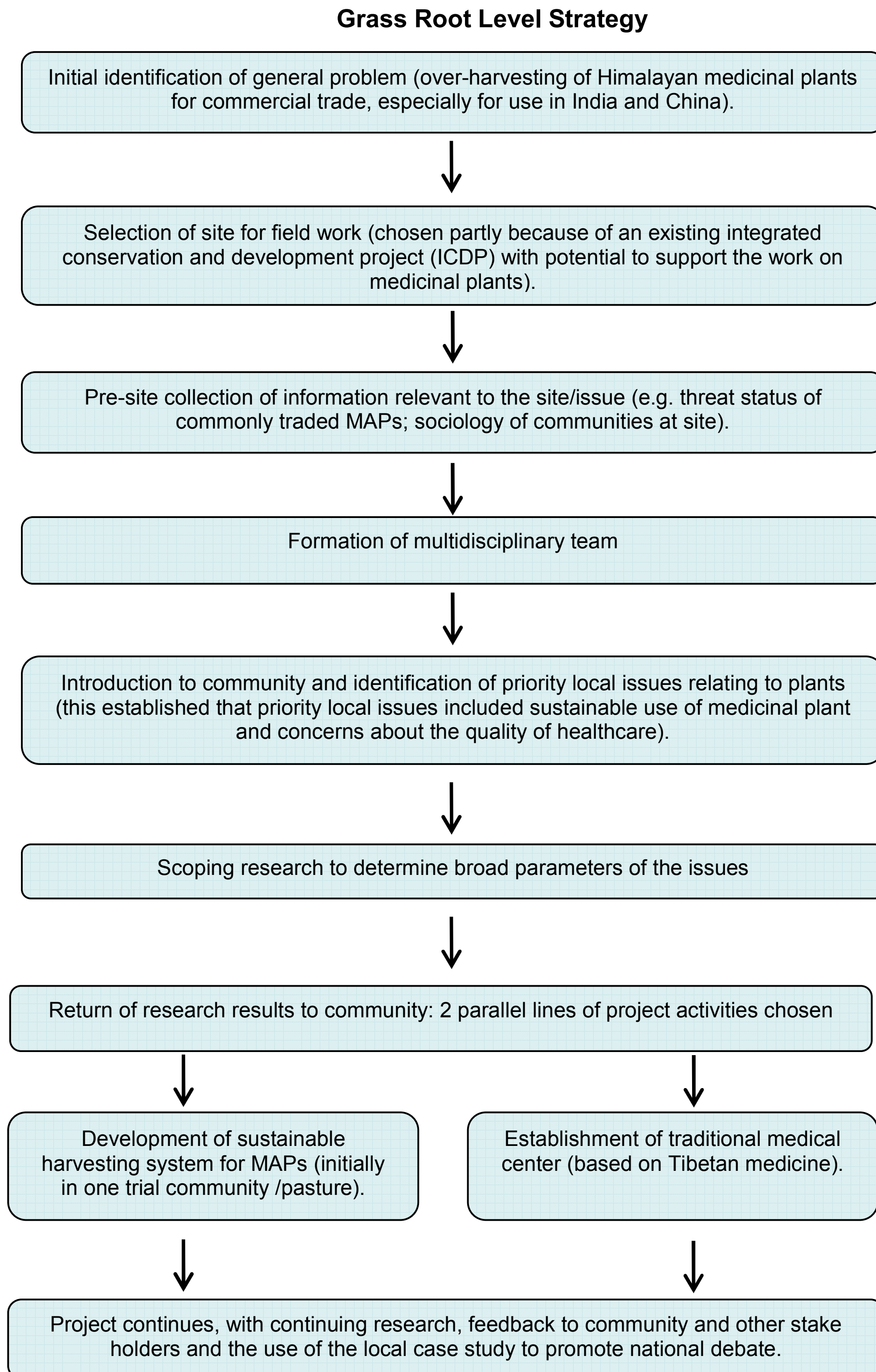
There is also a common belief that a wild harvested herb will be more therapeutically potent than the same herb when cultivated. In the natural habitat, the species is subjected to different types of competitive pressures resulting in the development of particular high quality secondary metabolites than in the monoculture-cultivated site. It has also been argued that while wild harvesting brings benefit to the most marginalized section of the society; however, its cultivation would shift the benefit to more rich people who have land and means.

2.5.3 Grass Root Level Conservation of the Medicinal Plant Resources and Associated Traditional Knowledge

In this section, I will describe two examples of the *modus operandi* of successful attempts of the conservation of the medicinal plant resources and associated traditional knowledge in two remote parts of Nepal. First is the World Wildlife Fund (WWF) project on utilizing the *Amchis*'s (Tibetan doctors) understanding for the conservation of medicinal plants as well as health care development at the Shey Phoksundo National Park in Dolpa district of Nepal (21). The second is the Biodiversity Conservation Network (BCN) administered and the Asia Network for Sustainable Agriculture and Bioresources (ANSAB) coordinated project on participatory utilization and conservation of medicinal and aromatic plants in the Humla district in the western Himalayas (22).

Dolpa district (7,889 km^2) lies on the north of the Dhaulaghiri range bordering with Tibet. It is one of the most remote parts of Nepal. Dunai, the district headquarter, has a hospital. The hospital remains almost empty because the doctor and nurses are reluctant to serve in this remote part. The prevalent health care and medication are offered by the *Amchis* (the Tibetan doctors). The *Amchis* base their practices on the Tibetan medical system and use the plants widely for healing purposes. Shey Phoksundo National Park (3555 km^2) of Dolpa district is the largest national park of Nepal. People of Tibetan origin numbering around 3500 were the main inhabitants of the park.

The project started by having several rounds of meetings to sort out the local conservation practices and associated developmental priorities. A multidisciplinary and multicultural team was constituted to work out the general picture of the status of the *Amchi*'s profession and the usage & management of the medicinal plants in Dolpa. The result was encouraging. The team found that the *Amchis* used 375 plants. Furthermore, they found that the *Amchis* had a remarkable knowledge about the collection sites as well as sustainable ways of the plant collection. Some twenty medicinal plants including jatamansi (*Nardostachys grandiflora*) and kutki (*Neopicrorhiza scrophulariiflora*) were found to be traded in large quantity from around Dolpa. The jatamansi and kutki were the prized herbs for the local inhabitants as well. A village named Pongmo inside the national park with rich medicinal plant resources, however, threatened by over harvesting by the



outside collectors was chosen for exercising community based sustainable management of medicinal plants. At the same time, ways to enhance the capabilities of the *Amchis* as well as the women group in the improvement of the health-care delivery were also sought.

Fieldworks centered on finding the relationship between local inhabitants, medicinal plant resources and the habitat from where these natural resources are obtained. Experimental plots to investigate the effect of different levels of jatamansi and kutki harvesting were set up. The *Amchis* were provided with forum to talk about their profession in terms of enhancing knowledge, finding the gaps and sorting out problems. A traditional health care center was established in Phoksundo Village Development Committee for the promotion of the *Amchi* health-care system. The center also cultivated the medicinal plants in its clinic yard and provided essential guidelines for sustainable harvesting and utilization of medicinal plant resources to the villagers. The above strategy is eloquently described in a flow-chart (23) given in page 38.

The second example is from another one of the most remote region of Nepal, the Humla district (5,655km^2). The project encompassed eight village development committees with a population of 9722 in 1745 households. The inhabitants comprised of people from both Tibetan and Hindu communities. Agriculture and pastoralism form the main occupation of the inhabitants. The area was very rich in biodiversity with 102 medicinal and aromatic plants of which 16 had commercial value, 31 had potential commercial value and the rest was for subsistence uses. Natural resources including medicinal and aromatic plants were exploited to a large extent to meet the human needs, some times beyond sustainable level. Those species, which had commercial value, suffered most. The collectors simply sold medicinal and aromatic plants to the buyers, the plants were air lifted to the cities in the Terai and finally, they ended up in India. Against this background, the Humla project commenced. The project treated biodiversity rich landscape and the inhabitants in the surrounding land as inseparable one entity and sought to test if additional benefits from the biodiversity were forthcoming, would the added incentives make the local inhabitants to identify and tackle the external and internal threats to the biodiversity. If so, this approach would lead to sustainability of the natural resources.

The project kicked off with the stakeholders (collectors, local leaders, women groups, traders and outside experts) planning meeting. Basic information as regards to the medicinal and aromatic plant resources, their collection, trade and marketing and socio-economic-cultural status of the community were gathered and analyzed. One of the outcomes of this analysis was that it was decided to establish a distillation plant for obtaining essential oils from aromatic plants such as rhizomes and roots of jatamansi (*Nardostachys grandiflora*) and sugandhawal (*Valeriana jatamansii*), leaves of sunpati (*Rhododendron anthopogon*), berries of dhupi (*Juniperus indica*) and others. To look after all the affairs of the project, a local community based organization called Humla Conservation and Development Association (HCDA) with relevant stakeholders as members was established. It turned out that there already existed Humla Oil Private Limited (HOPL) owned and operated by the local communities. Later, the Community Forest User Groups (CFUGs) of Humla, Humla Conservation and Development Association (HCDA) and Humla Oil Private Limited (HOPL) joined hand to assume full ownership of this enterprise. Let us see what the Community Forest User Groups (CFUGs) is all about. In a simple term, Community Forest User Groups (CFUGs) consist of the local inhabitants who have been traditionally using the forest in the past; however, at present they have taken in charge of the management of the forest. This is in accordance with the Forest Act (1993) and Forest Regulation (1995) which demand that

Community Forest User Groups (CFUGs) chalk out operational resource management and conservation plans of the community forests (CFs) to be submitted to the Government Department of Forest.

Because of the establishment of oil producing enterprise, the collectors were happy to get competitive price of their natural collections. Before the royalties from non-timber forest products (NTFPs) were the properties of the Government but now the Community Forest User Groups (CFUGs) received the royalties. The role of collector was now changed. He or she became both collector as well as processor of the raw materials thereby infusing in them the value of long time supply of the raw materials.

Based on the indigenous knowledge, skills and practices coupled with the external scientific knowledge, the Asia Network for Sustainable Agriculture and Bioresources (ANSAB) as a part of the project prepared species profile of the medicinal and aromatic plants detailing taxonomy, habitat and range, ecology, regeneration, resource management, utilization, marketing and socioeconomic issues. Furthermore, a revolving equity fund arrangement to be managed by Humla Conservation and Development Association (HCDA) was set up to assist the individual or groups to start and establish small-scale businesses based on collection and processing of the medicinal and aromatic plants. Basic literary classes as well as conservation teaching modules were prepared to create and raise conservation awareness among members of Community Forest User Groups (CFUGs). A district level federation of Community Forest User Groups (CFUGs) was created in Humla to function as platform for sharing and exchanging experiences and ideas. The federation was also thought to contribute consolidating Community Forest User Groups (CFUGs) in terms of getting new partners for collaboration, looking for income generating activities and voicing for equitable policy at local and national levels.

From the experiences of these two projects, three things become clear. First, a meaningful and sustainable conservation and management of natural resources works best only when the local inhabitants are made in charge of the conservation process. In doing so, the indigenous knowledge and problem solving skills are used to the fullest extent. Second, if some added benefit to the community is built in the management of natural resources strategy, people will realize the advantage firsthand. Creating Traditional Health Care Center in Phoksundo Village Development Community and establishing Humla Oil Private Limited in Humla brought tangible benefit in respective communities. Third, to kick-start and sustain such participatory process in natural resources conservation and management, external support in terms of technology, information and initial financial resources is deemed essential.

2.5.4 *In-situ* Conservation of Threatened and Endemic plants

For *in-situ* protection and conservation of the wild life, 26696 Km^2 of the total available land (18.32%) have been designated as the protective area in Nepal. The protected area includes eight national parks, four wildlife reserves, one hunting reserve and three conservation areas and five buffer zones. Out of 118 ecosystems found in Nepal, 80 ecosystems are covered in these protective area. Some examples of *in-situ* plant protection are given below. Several *Rhododendron* species and an endangered species, *Tetracentron sinense*, are protected in Makalu-Barun National Park. Similarly, another

threatened species, *Larix himalaica*, in Langtang National Park; substantial population of a threatened and a valuable timber plant, *Dalbergia latifolia*, in Parsa Wildlife Reserve; a threatened medicinal plant, *Pterocarpus marsupium*, in the Suklaphanta Wildlife Reserve and an endangered species, *Gnetum montanum,* in the Chitwan National Park and in the low-lying Arun valley in Makalu-Barun National Park have been protected (5).

2.5.5 Cultivation of Medicinal Plants in Nepal

Commonly cultivated medicinal plants worldwide are around 900 species. China cultivates around 100–250 medicinal plant species. The number of the medicinal plants cultivated in the continent of Europe is about 150. Still, the plants collected from the wild constitute the major source of the medicinal plants. It is believed that the wildly collected plants comprise of 70–90% in terms of the number of species and 50-70% in terms of the quantity.

In Nepal, experimental herbal farms are said to have been started as early as in 1937. Nepal Government established Herbs Production and Processing Company Limited (HPPCL) in 1981. Since then, organized cultivation and processing of the medicinal and aromatic plants started (24). Herbs Production and Processing Company Limited (HPPCL) cultivates the medicinal and aromatic plants in several herbal farms in different parts of the country that covers the area of about 300 hectares. Commercial cultivation of several exotic species of aromatic plants such as palmarosa (*Cymbopogon martini*), citronella (*Cymbopogon winterianus*), lemon grass (*Cymbopogon flexuosus*), Japanese mint (*Mentha arvensis*), German chamomile (*Matricaria chamomilla*) and French basil (*Ocimum basilicum*) have taken place. Herbs Production and Processing Company Limited (HPPCL) have also produced aromatic oils from jatamansi (*Nardostachys grandiflora*), timur (*Zanthoxylum armatum*), tagetes (*Tagetes minuta*) and sugandakokila (*Cinnamomum glaucescens*). The other major cultivators of the medicinal and aromatic plants are Dabur Nepal, Gorkha Ayurved, Nepal Sanskrit University, Sambala Herbal, Male International etc. Among the major cultivated medicinal and aromatic plants include *Swertia chirayita* (chiraito), *Valeriana jatamansii* (sugandhawal), *Asparagus racemosus* (satawari), *Zanthoxylum armatum* (timur), *Taxus wallichiana* (lauth salla), *Cinnamomum tamala* (tejpat), *Sapindus mukorossi* (ritha), *Phyllanthus emblica* (amla) and *Acorus calamus* (bojho).

Dabur Nepal has established medicinal plant nurseries in Banepa and Marpha. They are involved into research, conservation and cultivation of twenty-five species of endangered Himalayan Ayurvedic plants.

2.5.6 Harvesting Process

Collecting plants from the wild for some type of benefit characterize harvesting process. The plants are either cut or uprooted. Survival of the plant species for the next generation depends upon on how the plant or plant’s parts are dismembered and which time of the year it is done. Furthermore, the herds are grazed over high land pastures as well as the nearby forests. These practices are also putting pressure on the continued availability of these valuable genetic resources. The following are seen as major faults

with harvesting and production of non- timber forest products including the medicinal and aromatic plants (25). They are (a) destructive harvesting of the whole plant including roots and seeds before their production for the next season is ensured (b), harvesting of the plant species before they produce flowers and fruits minimizing their survival for the next generation (c), disregard for the right time for the harvesting of the plant species (d), rampant harvesting and collection of the plant materials from marginal or ecologically sensitive areas (e), dearth of the rotational collection practices (f), availability of the plant species in a large scattered areas making consistent supply of the quality raw materials difficult and (g) inappropriate methods of the post harvest treatments of the collected plant species such as cleaning, drying, grinding, storage and at times knowingly or unknowingly adulteration of the collected materials.

There have been some practical suggestions as regards to the right time for harvesting of the plant species (26). Whole plant needs to be harvested when it is completely matured. On the arrival of the blossoming, it will be desirable to harvest bark and leaves. When the plant is matured and flowering, flowers and seeds may be harvested. Rotational collection practice with period gap of 1–4 years is considered a good practice. In case of leaf, fruit, flowers, lesser time gap is fine but roots, rhizome, tuber, bark need longer rotation gap period perhaps as high as 4 years. To give room for regeneration, up to 30% of roots, rhizome, bulbs and whole plant; 50–60% of twigs and leaves and 90% of seeds harvesting at a time are considered okay.

2.5.7 IUCN Red List of Threatened Species

The International Union for the Conservation of Nature and Natural Resources (IUCN), known as the World Conservation Union was established in 1948. It is the premier international body to keep tract on the conservation status of the species. Its red list of threatened species (also known as the IUCN Red List or Red Data List) lists the species into nine catagories: extinct (EX), extinct in the wild (EW), critically endangered (CR), endangered (EN), vulnerable (VU), nearly threatened (NT), least concern (LC), data deficient (DD) and not evaluated (NE). In the IUCN red list, the official term “threatened” is a grouping of three categories: critically endangered, endangered, and vulnerable. The classifiaction on such groupings are done on the basis of criteria such as rate of decline of the species, their population size, area of their geographic distribution and the fragmentation of their habitats. Let us now see what the above terms stand for (27).

Extinct (EX) species is the one whose the last existing member has already died. ***Extinct in the wild (EW)*** is a conservation status assigned to species or lower taxa inwhich the only known living members are being kept in captivity or as a naturalized population outside its habitat range. ***Critically endangered (CR)*** organisms have an extremely high risk of becoming extinct. ***Endangered (EN)*** species is at risk of becoming extinct because it is either few in number or is threatened by changing environmental or predation factors. ***Vulnerable (VU)*** species is likely to become endangered unless the circumstances threatening its survival and reproduction improve. ***Near threatened (NT)*** is a conservation status assigned to species or lower taxa which may be considered threatened with extinction in the near future, although it does not currently qualify for the threatened status. ***Least Concern (LC)*** is an IUCN category assigned to extant species or lower taxa

which have been evaluated. And as such they do not qualify as threatened nor near threatened. ***Data deficient (DD)*** is a category applied by the IUCN to a species when the available information is not sufficient for a proper assessment of conservation status to be made. ***Not evaluated (NE)*** refers to the species which are not considered for current evaluation.

Taking into consideration of IUCN protocal, all together sixty plant species in Nepal are found to be threatened (5). In 1996, twenty-eight plants were listed according to then existent following IUCN nomenclature of threatened plant status ***(E = endangered; R= rare; V = vulnerable; K = insufficiently known)*** (4). In 2002, a conservation assessment and management planning (CAMP) workshop to assign conservation status to the flora found in the country was held in Pokhara, Nepal. The workshop was attended by eminent Nepali botanists, Government officials, herbalists, academicians and educators as well as by the IUCN international experts. The workshop designated IUCN red list category (version 3.1) to fifty-one plant species (28). Out of fifty-one plant species, three were critically endangered (CR), fourteen were endangered (EN), twenty-three were vulnerable (VU), three were nearly threatened (NT), one was least concern (LC) and seven were data deficient (DD) as seen in the below table.

Threatened Plants of Nepal

	Plants	Local name	IUCN Category (1996)	CAMP (2002)
1	*Michelia champaca* L.	Champ	E	CR
2	*Pterocarpus marsupium* Roxb.	Bijayasal		CR
3	*Rauwolfia serpentina* (L.) Benth. ex Kurz	Sarpagandha	E	CR
4	*Aconitum balangrense* Lauener	Bikh		EN
5	*Alstonia neriifolia* D. Don		R	EN
6	*Corydalis megacalyx* Ludlow			EN
7	*Crateva unilocularis* Buch.- Ham.	Siplikaan	R	EN
8	*Dactylorhiza hatagirea* (D. Don) Soo	Panchaunle		EN
9	*Dioscorea deltoidea* Wall.	Bhyakur	T	EN
10	*Ephedra intermedia* Schrenk & C. A. Mey.	Somlata		EN
11	*Gloriosa superba* L.	Kewari	R	EN
12	*Heracleum lallii* C. Norman			EN
13	*Operculina turpethum* (L.) S. Manso	Nisoth		EN
14	*Oroxylum indicum* (L.) Kurz	Tatelo	V	EN
15	*Otochilus porrectus* Lindl.			EN
16	*Pistacia chinensis* subsp. *integerrima* (J.L. Stewart) Rech.	Kakarsingi	R	
17	*Swertia angustifolia* Buch.-Ham. ex D. Don	Bhale chiraito		EN
18	*Taxus wallichiana* Zucc.	Lauth salla		EN
19	*Acacia catechu* (L.f.) Willd.	Khayar	T	
20	*Aconitum gammiei* Stapf	Bikh	R	
21	*Aconitum heterophyllum* Wall.	Atis	R	VU
22	*Aconitum laciniatum* (Bruhl) Stapf	Bikh	T	
23	*Aconitum spicatum* (Bruhl) Stapf	Bikh	T	VU
24	*Allium hypsistum* Stearn	Jimbu		VU
25	*Allium przewalskianum* Regel	Jimbu	V	

	Plants	Local name	IUCN Category (1996)	CAMP (2002)
26	*Alstonia scholaris* (L.) R. Br.	Chatiwan	R	VU
27	*Arnebia benthamii* (Wall. ex G. Don) Johnston	Maharangi		VU
28	*Asparagus racemosus* Willd.	Satawari		VU
29	*Bergenia ciliata* (Haw.) Sternb.	Pakhanbed	T	
30	*Butea monosperma* (Lam.) Kuntze	Palas	E	VU
31	*Curculigo orchioides* Gaertn.	Kalo musali		VU
32	*Dalbergia latifolia* Roxb.	Satisal	V	
33	*Delphinium himalayai* Munz.	Atis		VU
34	*Elaeocarpus sphaericus* (Gaertn.) Sch.	Rudrakshya	V	
35	*Ephemerantha macraei* (Lindl) Hunt. Sum.	Jiwanti		VU
36	*Fritillaria cirrhosa* D. Don	Kakoli		VU
37	*Nardostachys grandiflora* DC.	Jatamansi	V	VU
38	*Neopicrorhiza scrophulariiflora* (Pennel) Hong	Kutki	V	VU
39	*Paeonia emodi* Wall.	Chandra	R	
40	*Panax pseudo-ginseng* Wall.	Mangan		VU
41	*Paris polyphylla* Sm.	Satuwa	V	VU
42	*Piper longum* Linn.	Pipla		VU
43	*Podophyllum hexandrum* Royle	Laghupatra	V	VU
44	*Rheum australe* D. Don	Padamchal		VU
45	*Rheum nobile* Hook. f. Thoms.	Amalbetas	R	VU
46	*Rubia manjith* Roxb.	Majitho		VU
47	*Swertia chirayita* (Roxb. ex Flem.) Karstn.	Chiraito	V	VU
48	*Tinospora sinensis* (Lour.) Merr.	Gurju		VU
49	*Valeriana jatamansii* Jones	Sugandhawal		VU
50	*Jurinea dolomiaea* Boiss.	Dhupjadi		NT
51	*Meconopsis dhwojii* G. Taylor ex Hay			NT
52	*Rheum moorcroftianum* Royle	Padamchal		NT
53	*Arisaema costatum* (Wall.) Mart. ex Schott	Sarpko makai		LC
54	*Aconitum bisma* (Buch.-Ham.) ex Rap.	Bikh		DD
55	*Aconitum ferox* Wall. ex Seringe	Seto bikh		DD
56	*Lilium nepalense* D. Don	Khiraule		DD
57	*Maharanga bicolor* (Wall. ex G. Don) A. DC.	Maharangi	K	DD
58	*Maharanga emodi* (Wall.) A. DC.	Maharangi	K	DD
59	*Pongamia pinnata* (L.) Pierre	Karengi		DD
60	*Swertia multicaulis* D. Don	Sarmaguru		DD

2.5.8 Medicinal Plant Trade and CITES

The medicinal plants are in constant danger of being depleted or even vanished because of primarily two reasons. First is that some medicinal plants has been found to be subjected to unchecked and unsustainable harvesting for both domestic as well as international trade. Most of the time, harvesting method is crude and causes irreparable damage to the plants. The other is the ongoing destruction of the habitat by the human in form of development works such as road building and mining, agricultural expansion and simple human encroachment. The habitat loss means loss of biodiversity and the loss of

biodiversity means loss of valuable natural resources including medicinal plants.

In order to control the ever-booming illegal trade of wildlife and wildlife products, in 1975, a convention called the convention on the international trade in endangered species of fauna and flora (CITES) came into force (29). The member countries who have signed the CITES convention are required to keep tap on international trade in wild life and wildlife products and take necessary action, should a species be adversely affected by the international trade. Under the CITES, there are three levels of protections based on biological status of the species and the extent of suffering the species has faced by dint of international trade. The CITES Appendix I contains the species on the verge of extinction. If the trade is unchecked, there is likelihood that the species will be vanished. Hence, a ban has been in place for international trade of the species listed in Appendix I. Appendix II lists the species that are not endangered as the species in Appendix I; however, if the trade of such species remains unchecked and unmonitored, such species being threatened is a distinct possibility. Appendix II sometimes takes care of the entire genus or family or even order. Because at times, threatened and unthreatened members look alike and are difficult to be differentiated. By doing so, the threatened ones are sure to be protected. Appendix III refers to the optional list of native species to which an individual country can put as threatened as a result of excessive trade.

Putting the plants on CITES appendix is one thing, but really monitoring whether CITES plants are controlled or regulated from international trade is another. Several difficulties arise. Medicinal plants as commercial entities take different shapes and forms. Plants are traded in form of barks, roots, stems, processed or semi-processed, powdered or as even finished product as a medicine. As a consequence, from their outer appearance, difficulty lies on the identification of the plant source. Not only this, at times, problem is faced by multiple uses of the same plant. For example, orchids have been historically traded for the horticultural purpose. However, it turns out that orchids were found to be traded for medicinal purposes in large quantity as well. Disguised trade remains a problem. Putting the plant for one purpose and doing the trade for different purpose is common.

CITES Listed Plants of Nepal

	Plant	CITES Appendix
1	*Ceropegia pubescens* (Mirke lahara)	II
2	*Cyathea spinosa* (Rukh unyu)	II
3	*Cycas pectinata* (Kalbal)	II
4	*Dioscorea deltoidea* (Bhyakur)	II
5	*Gnetum montanum* (Bhote lahara)	III
6	*Meconopsis regia* (Kyashar)	III
7	*Orchidaceae* spp. (Sunakhari)	II
9	*Podocarpus neriifolius* (Gunsi)	III
10	*Podophyllum hexandrum* (Laghupatra)	II
11	*Rauvolfia serpentina* (Sarpagandha)	II
12	*Talauma hodgsonii* (Chanp, Bhalu kath)	III
13	*Taxus wallichiana* (Lauth salla)	II
14	*Tetracentron sinense* (Jharikote)	III

Sometimes, a plant is included in CITES but its products and derivatives are found to be exempted from the international trade. Often cited example is of that of the Himalayan yew (*Taxus wallichiana*). The Himalayan yew contained anticancer compound called taxol. Rampant collection of the bark and leaves of the Himalayan yew plant for taxol and subsequent illegal trade brought about huge reduction of the plant in the natural habitat. In 1994, the Himalayan yew was included in CITES Appendix II list. However, the derivatives and products obtained from the plant was not covered in CITES Appendix II and therefore, they were exempted from CITES control. Because of this, the trade of the Himalayan yew in form of semi-processed or processed chemical derivatives remained unabated.

In Nepal, several wild plant species have suffered to a substantial extent due to over harvesting and habitat loss. In line with the Forest Act 1993 and Forest Rules 1995 which ensures the development, conservation and proper utilization of the forest resources, the Government of Nepal has decided to protect 17 plant species under three categories (i) banned for collection for collection and export (ii) banned for export without processing and (iii) banned for felling, transportation and export as seen in the following table (30).

Protected Plants of Nepal

Banned for collection and export		
1	*Dactylorhiza hatagirea*	Panchaunle
2	*Juglans regia* (bark)	Okhar ko bokra
3	*Neopicrorhiza scrophulariiflora*	Kutki
Banned for export without processing		
1	*Nardostachys grandiflora*	Jatamansi
2	*Rauvolfia serpentina*	Sarpagandha
3	*Cinnamomum glaucescens*	Sugandha kokila
4	*Valeriana jatamansii*	Sugandhawal
5	*Lichen* spp.	Jhyau
6	*Abies spectabilis*	Talispatra
7	*Taxus wallichiana*	Lauth salla
8	*Rock exudates*	Silajeet
Banned for felling, transportation and export		
1	*Michelia champaca*	Champ
2	*Acacia catechu*	Khayar
3	*Shorea robusta*	Sal
4	*Bombax ceiba*	Simal
5	*Dalbergia latifolia*	Satisal
6	*Pterocarpus marsupium*	Bijayasal
7	*Juglans regia*	Okhar

2.5.9 The Forest Stewardship Council (FSC) Certification

A group of members from the Government, Non-Governmental Organizations (NGO), herbal industries and the donor foreign agencies have joined hand with a forest certification organization, Rainforest Alliance, in establishing a mechanism of issuing the Forest Stewardship Council (FSC) certification to the Nepali herbs and herbal products (31). Issuing such certification would on one hand help protect the valuable natural resources and on the other increases the salableness of the forest products in the international market. Nepal became the first country in Asia and fifth in the world to acquire the Forest Stewardship Council (FSC) certification for medicinal plants and non-timber forest products.

2.6 Nepal Government Commitments for Medicinal plants

In Nepal, experimental herbal farms were started as early as in 1937. The establishment of The Department of Plant Resources (formerly known as Department of Medicinal Plants) in 1960 seems to be the first official commitment from the Government side for the promotion of the medicinal plants in Nepal. The department has the following major mandates: surveying and collecting plant resources and preserving the specimens in the national herbarium; establishing and maintaining botanical gardens in different parts of the country; conducting chemical and biological researches with an aim to optimum utilization of medicinal, aromatic and other plant resources and developing agro-technology on plants and providing services to the farmers on techniques of commercial cultivation of important medicinal and economic plants. Although Government's five year plans started since early fifties and subsequent plans spoke about conservation and utilization of the forest, medicinal plants and herbs did not find respectable mention in these plans. The Forestry Sector Master Plan (1989) recognized the development and management of medicinal plants as one of its primary programs. The eighth Five-Year Plan (1992–1997) attempted to connect the medicinal plants and related resources to income and employment generation for rural marginalized people as well as the conservation of the ecosystem and biodiversity. The Ninth Five-Year Plan (1998–2002) saw the medicinal plants and related resources as one of the ways to reduce poverty in the rural areas. The Tenth Five-Year Plan (2003–2008) promulgated with the core objective of poverty alleviation stressed on sustainable production, processing and marketing of the medicinal plants and related resources. The Forest Act 1993 and Forest Rules 1995 ensure the development, conservation and proper utilization of the forest resources. Nepal Biodiversity Strategy (2002) acknowledged medicinal plant and other resources as the national wealth and emphasized on medicinal and aromatic plants cultivation as well as development of medicinal and aromatic plants and other non-timber forest products based enterprises. In 2002, the Government of Nepal constituted a high-powered Herb and Non-Timber Forests Products Coordination Committee (HNCC) under the chair of the Minister of Forest and Soil conservation. The other members of the committee included representatives from various related Government agencies, National Planning Commission, Nepal Academy of Science and Technology (NAST) and Asia Network for Sustainable Agriculture and Bioresources (ANSAB). The committee is entrusted to (a) formulate national policies & relevant laws for sustainable development

and proper utilization of herbs and non-timber forest products (b), finalize strategic activities and maintain inter-agency coordination and (c) coordinate herb & non-timber forests products related conservation, research, technology development, market management, training and publicity activities. Among the first works of the committee included identification of the national priority herbs for their further development, research and cultivation. Based on the criteria such as national and international commercial demand, geographical range of distribution, local use and inherent medicinal properties, thirty plant species have been recognized as national priority herbs (See page 32).

In 2004, the Government promulgated the herbs and non-timber forest products (NTFPs) development policy. This policy and the amendment in the forest regulation (2005) revised the long awaited royalty rates of several non-timber forest products. The policy has also highlighted Government's strategies for the promotion and development of the non-timber forest products. Among the Government's strategies include enhancing competence of Government Organizations and Non-Government Organizations (NGOs) working responsively in non-timber forest sectors, helping set up and promote Ayurvedic and medicinal plant based industries, inviting private and foreign investment for establishment of advanced and large scale industries based on locally available non-timber forest products, promoting traditional knowledge and skills through micro and medium scale industries by domestic investor and emphasizing scientific storage, processing, packaging and chemical extraction of highly potential non-timber forest products.

2.6.1 Collection and Export of the Plants

Through the Forest Act 1993 promulgated by Ministry of Forest and Soil Conservation, the harvesting, processing and trade of the non-timber forest products including medicinal plants are administered. For the collection of the non-timber forest products from the Government forests and pasturelands, the permit for collection is required from the District Forest Office (DFO). Like wise, Community Forest User Groups (CFUs) issue the permit for the collection of non-timber forest products from the community forests. The collector's application should clearly mention the name and types of medicinal plants, place of location, required quantity and purposes of the collection whether for domestic use or for export. After the collection, the collector pays royalty for the collected medicinal material to the respective agency. The District Forest Office hands over the release letter to the collector. If the collected material is meant for export, a recommendation letter suggesting the collected plant materials are not prohibited for export addressed to the custom office from District Forest Office is required. For the export of processed medicinal and aromatic plants, their extracts or their byproducts, Department of Plant Resources (DPR) under Ministry of Forestry and Soil Conservation issues the permission letter after careful examination of the processed materials. Before exporting the plant or plant products, phytosanitary certificate describing the good health of the plant is required in accordance with Nepal Plant Protection Act 1972 and Plant Protection Rules 1975. Plant Quarantine Section (PQS) of Department of Agriculture issues this certificate.

2.6.2 Regulation of Herbal Products

In accordance with the Nepal Drug Act 1978, all the pharmaceutical products including herbal medicines are regulated (32). Department of Drug Administration of Ministry of Health and Population is the national regulatory authority. In addition, for regular testing, analysis and research of the pharmaceutical products, the Government has established a National Reference Laboratory. As far as the registration of domestic pharmaceutical products are concerned, the requirements include a letter of recommendation for establishing a drug industry and obtaining product license, registration for manufacture and sale of the products in compliance with national guidelines for good manufacturing practices (GMP). For the imported products, the registration of the sale and distribution of the products as well as a letter of recommendation for import of drugs in compliance with WHO good manufacturing practices (GMP) guidelines are required. Furthermore, valid certification of the pharmaceutical products as recommended by WHO, detail description of the formulation such as excipients, color, flavor & sample of the product, sample analysis from own lab as well as one report of analysis from some other recognized lab are required.

2.6.3 Policy Issues

One Nepali expert is critical of the prevailing policy and institutional framework as regards to non-timber forests products (NTFPs) development in Nepal (33). The expert describes four policy issues: regulatory policies, fiscal policies, institutional issues and marketing and trade issues. Regulatory policies include the permit for collection from District Forest Office for the non-timber forests products from the Government forests and pasturelands and from Community Forest Users Group from community forests. District Forest Office issues transit and export permits. For the processed products, permit has to be obtained from Department of Plant Resources (DPR) located in the capital, Kathmandu. Ban has been imposed on the collection of three high value species and the export of eight medicinal plants in raw forms. Non-timber forests products are subjected to multiple checks along the transportation road. This causes inconvenience as well as side payments. Fiscal policies refer to the taxes and subsidies that are imposed right from the collection stage to the export stage of the non-timber forests products. Different types of informal taxes are also seen in place such as police, school, village development committee, district development committee, municipality etc. Export tax of 0.5% of the value of the product is also imposed. In the institutional set up, two main actors are District Forest Office and Community Forest Users Group. Other stakeholders are obviously those who are involved in harvesting, processing, marketing and trade of non-timber forests products. How these stake holders interact with each others determines to a large extent the sustainability of the non-timber forests products trade. Community Forest Users Group's operational plan is prepared for a period of five year and is approved by District Forest Office. It is too restrictive in the sense that they require special permission for non-timber forests products harvesting. It has been also shown that issuing permit and levying taxes are not uniform and differ from place to place. As regards to the marketing and trade issues of non-timber forests products, it is stated that the collectors, traders as well as the government officials lack adequate knowledge about

marketing information of non-timber forests products. Officials involved in the regulation of non-timber forests products collection and export often lack the expertise in the identification of the plant materials. Medicinal and aromatic plants having more than one name might incur two different rates of royalties.

The expert argues that ban on the export of non-timber forests products should be lifted. Government should be in a position to derive royalty from the collection, processing and trade of such renewable resources. Not only the Government, other stakeholders such as harvesters, traders and exporter are likely to benefit from revoking such bans. It is also suggested that in view of the fluctuating market prices of non-timber forests products, the royalty rate levied on non-timber forests products should accordingly be adjusted. Not only this, the royalty for the plant of different local names but belonging to the same species should be the similar. For doing so, officials who are involved in the royalty and tax collection should be trained in the proper identification of non-timber forests products. If this is properly done, the royalty and tax worthy of specific medicinal plants can be collected. Another suggestion forwarded is that Community Forest Users Group members as well as other personnel involved in non-timber forests products management should be provided technical training for harvesting, storage and possible processing of the plant products for increasing productivity and sustaining the natural resources. In line with the agreement with the Government, Community Forest Users Group submits the operational plans for a period of five years. Community forest users group is not allowed to collect revenues from the collection of the plants, which are not mentioned in the operational plan. In order to give more leverage to the Community Forest Users Group, provision of revising the operational plan should be introduced. Which agency should be in charge of collecting revenues from the non-timber forests products grown in the private lands appears not to be in place. It is also suggested that credit facilities such as micro financing need to be introduced in the remote areas so that the collector will have alternative source of finance other depending upon the traders for credit. It is also argued that if part of the income of the revenues is provided to the house holds who put their labor to manage non-timber forests products in the community forests, this will help on one hand to reduce their poverty to some extent and the other will add further incentive for the proper management of the natural resources.

2.7 Medicinal Plant Trade

Medicinal plants have both domestic as well as international markets. Three level of trading avenues for the medicinal plants have been identified. The first level is the national market where medicinal plants and herbs are traded. Examples can be cited of the Terai cities such as Nepalgunj and Dhangarhi where large volume of Nepali medicinal plants and herbs are put on sale. The second trade avenue is the informal trade of the medicinal plants and herbs across the national borders. Here also we can refer to several medicinal plants from Nepal such as *Nardostachys grandiflora*, *Valeriana jatamansii* and others, which end up illegally in India. The third avenue is the formal export trade of the medicinal plants or the products processed from the medicinal plants.

Where are the medicinal plants traded? Who needs the medicinal plants? Demand

for the medicinal plants comes from the following sectors (34).

a) Pharmaceutical companies: Pharmaceutical companies need medicinal plants and herbs to process them into medicine. This is done through several ways. Medicinal plants are subjected to the separation process to obtain purified single drug. The drugs such as morphine/codeine (analgesics), emetine (emetic), quinine (antiparasitic), vinblastine/vincristine/taxol (antineoplastic), atropine (anticholinergic), artemisinin (antimalarial), to name a few, are all obtained in pure form from the plant sources. The names, sources of the plant and clinical uses of the selected drugs obtained from the plant are given in the following table.

Selected Drugs Obtained from the Plant

Drug	Plant source	Biological property/Clinical use
Artemisinin, Artemether	*Artemisia annua*	Antimalarial
Atropine	*Atropa belladonna*	Anticholinergic
Berberine	*Berberis vulgaris*	Bacillary dysentery
Camptothecin	*Camptotheca acuminata*	Antitumor agent
Caffeine	*Camellia sinensis*	CNS stimulant
Cocaine	*Erythroxylum coca*	Local anaesthetic
Codeine, Morphine	*Papaver somniferum*	Analgesic, antitussive
Digitoxin	*Digitalis purpurea*	Cardiotonic
Emetine	*Cephaelis ipecacuanha*	Amoebicide, emetic
Ephedrine	*Ephedra sinica*	Sympathomimetic, antihistamine
Etoposide, Podophyllotoxin	*Podophyllum peltatum*	Antitumor agent
Galanthamine	*Lycoris squamigera*	Cholinesterase inhibitor
Hyoscyamine	*Hyoscyamus niger*	Anticholinergic
Menthol	*Mentha* species	Rubefacient
Methyl salicylate	*Gaultheria procumbens*	Rubefacient
Quinine	*Cinchona ledgeriana*	Antimalarial, antipyretic
Reserpine	*Rauvolfia serpentina*	Antihypertensive, tranquillizer
Salicin	*Salix alba*	Analgesic, antipyretic
Scopolamine	*Datura* species	Sedative
Sennosides A, B	*Cassia* species	Laxative
Strychnine	*Strychnos nux-vomica*	CNS stimulant
Taxol	*Taxus brevifolia*	Antitumor agent
Theobromine, Theophylline	*Theobroma cacao*	Diuretic, brochodilator
Vinblastine, Vincristine	*Catharanthus roseus*	Antitumor, antileukemic agent

At times, the compounds isolated from the plant will be made starting material in order to produce even more pharmacologically active substances. Long time ago, in 1825–1826, one pure compound called salicin was isolated from the bark of the white willow, *Salix alba*. Although salicin was helpful in relieving pain (analgesic) and

reducing fever (antipyretic), it had one serious side effect. It caused gastrointestinal irritation. To overcome this problem, salicin was converted into acetylsalicylic acid. Acetylsalicylic acid, popularly known as aspirin is number one analgesic and antipyretic drug even today. Similarly, several cardiotonic drugs have been synthesized from digitoxin, an active principle isolated from the foxglove, *Digitalis purpurea*. The list is long.

As early as in 1985, it was shown that there were 119 single component drugs derived from the medicinal plant in use worldwide. Interestingly, most of these medicinal plants had been identified by their use in the century old ethnomedical practices (35). Natural products derived drugs occupied respectable position in worldwide selling of top 35 ethical drugs, 40% in 2000, 24% in 2001 and 26% in 2002 (36). From 2000 to 2005, 20 new drugs either obtained or inspired from natural sources were marketed worldwide (37).

Every so often, plant standardized extracts with the known active ingredients in almost fixed amount also serve as medicines. For example, St. John's wort (*Hypericum perforatum*) extract containing active ingredients hypericins and hyperperphorin as antidepressant, ashwagandha (*Withania somnifera*) containing active ingredients withanolides as adaptogen and valerian (*Valeriana officinalis*) containing valepotriates as sedative are widely used. The following table gives the description and examples of the types of herbal therapeutics.

Types of Herbal Therapeutics

Category	Description	Example
Drugs	Single compound obtained from a botanical source used in the prevention and treatment of the diseases	Paclitaxel, morphine, aspirin
Herbal medicine	Product obtained from the botanical source consisting of one or more than one plant for use in the prevention and treatment of the diseases	Polyphenone E, Senekot
Nutraceuticals	Diet supplemented with the extracts or nutrients that are not natural to the diet	Garlic extract
Food additives	Purified mixture which affect food characteristics	Carrageenan, hop extract
Dietary supplements	food or food ingredient that provide a health benefit beyond the nutrients it contain	Flavocoxid
Cosmeceuticals	Extract which supplement cosmetic products	Aloe cream

For the production of such important medicines, substantial amount of the medicinal and aromatic plants are traded globally.

b) Traditional Medical System: Traditional medical systems such as Ayurveda, Traditional Chinese Medicine, Unani, Siddha, Tibetan, Kampo etc utilize the plant resources to produce traditional medicines. Up to 6000 medicinal plants are reported to have been used in the traditional Chinese medicine; however, commonly used plants range from 500 to 600. In Ayurveda, 1250–1400 plant species are used. Similarly, in

Tibetan medicine 1106–3600 species, in Unani 342 species and in Siddha 328 species are likely to be used. Given the equal status given to the traditional Chinese medicine as the allopathic medicine in China and growing popularity of Ayurveda in the Indian sub-continent as well as the increasing universal attraction of the other forms of traditional medicine, one can envisage that the volume of the global requirement these medicinal plant resources will swell over the years.

c) Folk Medicine: Folk medicines usually practiced by the indigenous and ethnic communities also require vast amount of plant materials for the production of the folk medicines. In comparison to the scholarly medical systems such as the Ayurveda and the traditional Chinese medicine, folk medicines use far more number of the plants for the health care.

d) Alternative Medicines: Alternative medicine or complementary medicine has taken ground root in western countries. In such system, scientific evidence is sought for the traditional medical uses. Health foods, herbal teas and herbal tonics are in great demand in the western countries and Japan. Usually in order to avoid complex and expensive process of obtaining license as medicine, these products are sold as the health products or dietary supplements. Dietary supplements include vitamin, mineral, herb, amino acid, metabolite or an plant extract. Nutrition providing products commonly called nutraceuticals are in vogue. Foods are enriched with nutrients which are not natural to the food. There is growing demand for herbal creams, soaps and shampoos. For preparation of such products also, huge volume of the medicinal and aromatic plants is required.

2.7.1 Medicinal Plant Market Chain

From the medicinal plant harvesting to its final trade involves several stakeholders. The major stakeholders are local collectors or harvesters, local cooperatives, road-head and airport traders, regional traders, exporters, big processors and manufacturers and retailers (38). They all have specific role to play.

a) Local collector or harvesters consist of poor marginalized section of the community. They include women, children and elderly people as well. Harvesting of the medicinal plants is the seasonal employment. The meager income they obtained from harvesting is critical for their survival. They lack knowledge and resources for business and entrepreneurship. After harvesting, they often perform initial cleaning, drying and storage of the collected plant materials and sell them to the village traders. Their share on the entire business chain is the smallest.

b) Local porters help carry the harvested materials from the collection site to the nearest road- head. They are also among the poorest section of the community.

c) Forest user groups (FUGs) manage the local forest resources. They are independent body. The group includes people of different economic, social and political backgrounds. They are looking for different needs and opportunities from the forest. They may also involve in harvesting, trade, resource management, regulation and local processing.

d) Village traders are influential village group. They are relatively rich from the village standard; however, poor from the national perspective. They acquire the medicinal plants from the harvesters on credit basis. At times, they also lend money received as an advanced payment from the regional traders to the harvesters. They are also likely to counsel harvesters and Forest user groups (FUGs) on the matter of harvesting and collecting, drying and storage. They work on low profit margin.

e) Local processors come from among the collectors, forest user groups (FUGs) and local traders. They use simple available technologies for drying (solar dryers), fibre extraction, hand-paper making and distillation. By doing such processing, the volume of the material is reduced and so is the cost of the transportation.

f) Local cooperatives are registered groups of local harvesters normally established from outside help. They may obtain state subsidies but are bar from doing business. Harvesting, processing and trading are the main functions of the local cooperative.

g) Road-head and Airport traders are relatively rich and educated. They may include district elites, political leaders, businessmen and other services providers. They are generally from around district head quarter. They know non-timber forest business relatively well. They generally possess knack for dealing with Government and regulatory personnel. They are in large numbers compared to the volume of their trade and therefore they are in cut-throat business.

h) Regional traders are traditional business groups who have elevated investment abilities. They are in constant touch with road-head traders as well as with village traders and local harvesters as well. They possess political clout and are adept at business matters. Packaging, storing and trading of the non-timber forest products are their chief business activities.

i) Exporters are small in numbers. They are educated and professional traders. They are well versed on international market trends and export/ import rules and regulations. They utilize internet facilities. Their major businesses are grading, cleaning, drying, packaging, export complying with certification and trade regulation.

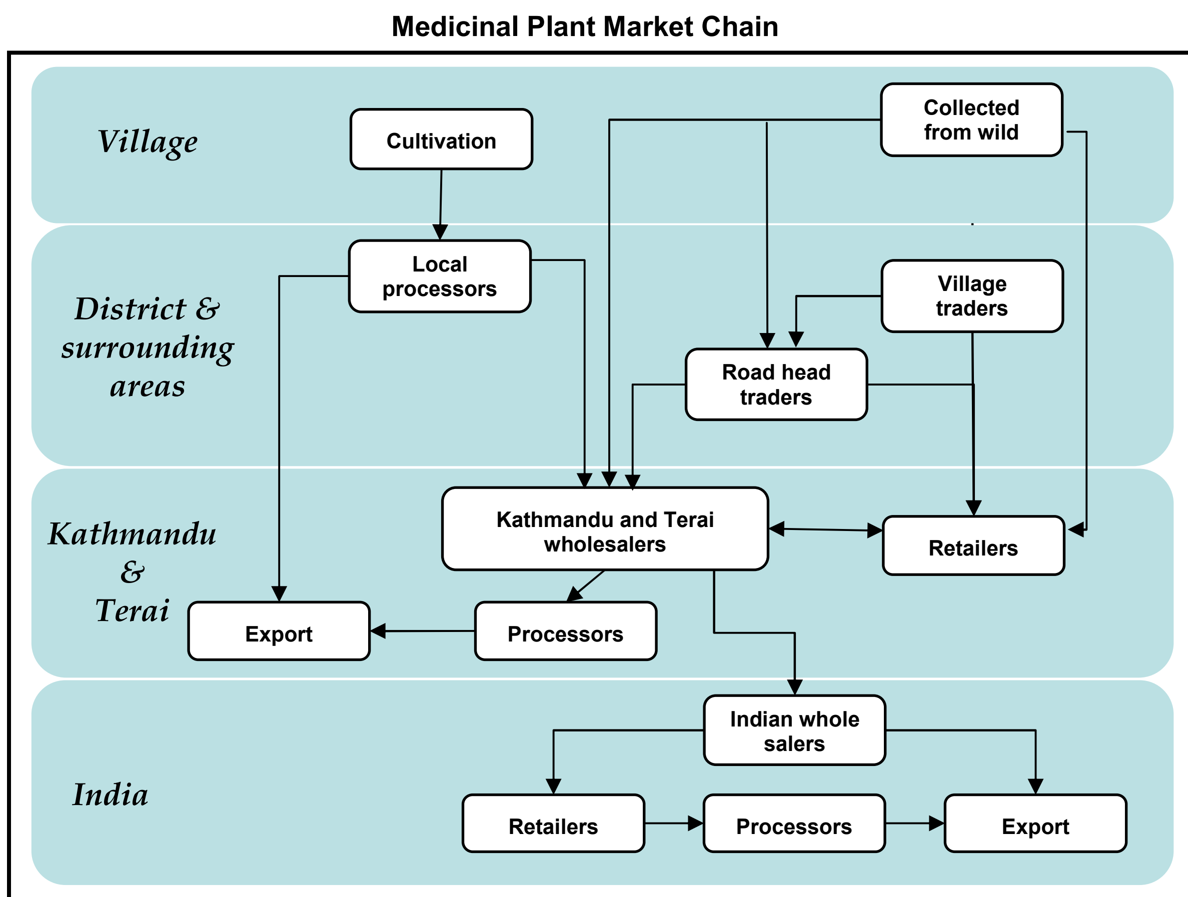
j) Big processors and manufacturers are national establishment from both public and private sectors. Some of them have research and development facilities. They are managed by the professional and influential people. At times, they complain of political interference in their business decisions. They process and manufacture non-timber forest based products.

k) Retailers could be small businesspersons or big business houses in big cities. Their business dealings cover a wide spectrum of herbal medicines, wild vegetables, spices and other processed or semi processed products.

The medicinal and aromatic plants collected in the mountains are brought to either Terai cities such as Dhandgadi, Nepalgunj, Krishnanagar, Bhairahawa, Birgunj, Biratnagar, Kakarbhitta or to the capita city of Kathmandu and other mountainous cities

as Pokhara. From these cities, they are mostly traded to India. Quite a bit of herbs is traded to Tibet and other regions of China. Some few herbs end up in foreign countries as well. The above description is illustrated in the following flow-chart.

Medicinal Plant Market Chain



One case study done at four non-timber forest products (*jatamansi* roots, *sugandhawal* roots, *kutki* roots and *gucchi chyau*) traded from the Karnali zone shows the picture of the profit the actors in the trade chain make (39). Regional traders made the most money and the harvesters the least. The regional traders's profit was 4307 times higher than that of a harvester, 73 times than that of a village trader and 4 times than that of road-head traders as can be seen from the following table.

Profit Distribution in the Market Chain

Participants	Total Estimated Profit (Rs)	Estimated Number of Actors	Estimated Profit per Person (Rs)
Harvesters	8,772,000	15,000	585
Village traders	3,422,000	100	34,220
Road-head and airport traders	12,138,000	20	606,900
Regional traders	12,600,000	5	2,520,000
Total	36,932,000	15,055	2,453

The harvesters are in disadvantageous position. The harvesters are large in number and each has small quantity to offer. They are unlikely to sell the products in the cities. They have to depend upon the road head or airport traders for marketing of their products. They are deprived of the marketing information. Usually the road head or airport traders provide credits to them prior to the collection. All these put the harvesters and village traders in a weak bargaining position. Furthermore, when the trade becomes informal or illegal, those who are in the initial level in the market chain are bound to suffer most.



Collectors marching for Yarshagumba (*Cordyceps sinensis*)

2.7.2 Worldwide Trade

Worldwide trade in the medicinal and aromatic plants is staggering. Out of more than 50, 000 medicinal plant species used globally, around 2500 species are thought to be in trade. In 2005, 400,000 tons of the herbal plant raw materials were transacted in international business. The total amount of money transaction of global medicinal and aromatic plants & their products trade is believed to be in the range of $ 70.5 billion with annual growth rate of 10 to 12% (40). European Union takes about forty-five percent of world's total share amounting to about US $ 32 billion. Japan is shown to have around 11% of the total trade share and rest of Asia 17%. The global trade in the medicinal and aromatic plants & their products is estimated to reach US $ 5 trillion by the year 2050.

Break-down of Worldwide MAPs Trade

	Region/country	Percentage of total share (%)	Actual amount ($ billion)
1	European Union	45	32
2	Asia	17	12.2
3	Japan	16	11
4	North America	11	7.7
5	Rest of Europe	4	2.8
6	Others	7	4.8

2.7.3 Medicinal Plant Trade in Nepal

In the year 1998–1999, total annual trade of the medicinal and aromatic plants from Nepal to India amounted to the US dollar value of 3.2–12.8 million. Of 2400–9400 tons of exported herbal resources, five species are *Nardostachys grandiflora, Swertia chirayita, Neopicrorhiza scrophulariiflora, Zanthoxylum armatum* and *Sapindus mukorossi* made up more than 50% of the total export (41). Around same time, one another report stated that the non-timber forest products trade to India amounted to US dollar 26.7 million (42). Experts believe that illegal trade of the medicinal plants is rampant. As early as in 1993–1994, an estimation suggested that the Government's revenue collection from the non-timber forest products (NTFPs) should have been US dollar 700,000 instead of the actual collection of the US dollar 150,000 pointing to ineffective revenue collection machinery (43). In one another instance, from Makwanpur district 178 tons of nine species of the medicinal plants were found to be traded but the Government record failed to document any of them (44). Considering the fact that substantial amount of the trade is through informal channel and considerable trade figure does not end up in the Government record, exact figure of the trade is difficult to get by. Nevertheless, one can safely say that the medcinal plant trade in Nepal is sizeable. Some estimate that the contribution of the non-timber forest product (NTFPs) to Nepal's gross domestic products (GDP) stands at 5% (26) (45). One hundred and fourty-three plant species have been evaluated and projected as commercial medicinal and aromatic plants in Nepal (46). In the year 2004/2005, the Ayurvedic/Unani medicine worth of Nepali rupees 342 million and Homeopathic medicine worth of Nepali rupees 5 million were imported to Nepal. The domestic production of the Ayurvedic/Unani medicine amounted to rupees 62 million. (US dollar 1 = 75 rupees) (47).

In 2004, a study was undertaken to study the domestic market of the medicinal and aromatic plants in Kathmandu valley, Nepal (48). It was found that annual demand of 195 medicinal plants and herbs amounting to 1031481 Kg and 19 species of the aromatic plants amounting to 38975 Kg exist in Kathmandu valley. Those medicinal and aromatic plants whose demand is more than 10000 Kg per year are given in a table in page 58.

Out of 214 medicinal and aromatic plants required in Kathmandu valley, 128 species are obtained from Nepal, 75 species from India and rest species either from Nepal or from India. Those imported from India included several plants easily available in Nepal such as *Creteva religiosa, Eclipta prostrata, Phyllanthus amarus, Cedrus deodara, Coriandrum sativum, Tamarindus indica, Holarrhena pubescens, Syzigium cumini, Acacia catechu, Saussurea lappa, Centella asiatica, Bombax ceiba, Cyprus rotundus, Operculina turpethum, Stereospermum chelonoides, Butea monosperma, Boerhavia diffusa.* These species although natively found are apparently not introduced in trade in Nepal. Difficulty in proper identification, inappropriate harvesting, unsuitable processing and storage facilities and lack of incentives were cited as the reasons why such plants although in high demand are not in the domestically produced. Kathmandu retailers also complained about somewhat poor quality of some plants such as *Terminalia chebula* (harro), *Terminalia bellirica* (barro), *Cinnamomum zeylanicum* (dalchini), *Phyllanthus emblica* (amla) due to lack of quality control measures. Among the major constraints for the domestic marketing of the medicinal and aromatic plants, the study pinpointed the

following factors: the supply of the medicinal and aromatic plants in inadequate volume; the inconsistent & not up to the mark quality of the plant materials most probably because of unscientific handling and storage facilities; unavailability of local processing units for the medicinal and aromatic plants; capturing of the market by handful of the retailers and leniency in the enforcement of the government rules and regulations.

Medicinal and Aromatic Plants Required in Kathmandu Valley

	Plants	Trade name	Parts used	Required amount (Kg)	Source of plant
1	*Taxus wallichiana* Zucc.	Lauth salla	Leaf	350200	Nepal
2	*Pinus roxburghii* Sargent	Salla ko khoto	Resin	190000	Nepal
3	*Piper longum* L.	Pipla	Fruit/root/stem	72500	Imported
4	*Piper chaba* Hunter	Chabo	Fruit	55000	Nepal/imported
5	*Phyllanthus emblica* L.	Amla	Fruit	50000	Nepal/imported
6	*Ocimum sanctum L.*	Tulsipatra	Whole plant	32000	Nepal/imported
7	*Rauvolfia serpentina* (L.) Bench	Sarpagandgamul	Root	30225	Nepal/imported
8	*Operculina turpethum* (L.) Silva	Nisoth	Root/bark	30000	Imported
9	*Aegle marmelos* (L.) Corr.	Bel	Fruit	25000	Nepal
10	*Swertia chirayita* Roxb. ex (Flem.) Karst	Chiraito	Whole plant	21000	Nepal
11	*Tinospora sinensis* (Lour.) Merr.	Guduchi	Stem	20000	Nepal
12	*Terminalia chebula* Retz.	Harro	Fruit pulp	16625	Nepal/imported
13	*Cinnamomum tamala* (Buch.-Ham.) Ness & Eberm.	Tejpat	Leaf	16000	Nepal
14	*Cinnamomum zeylanicum* Breyn.	Dalchini	Bark	12000	Imported
15	*Terminalia bellirica* (Gaertn.) Roxb.	Barro	Fruit pulp	10000	Nepal/imported
16	*Bombax ceiba* L.	Bamsalochan		7250	Imported
17	*Zingiber officinale* Rose.	Aduwa, Sutho	Rhizome	6000	Nepal
18	*Cinnamomum glaucescens* (Nees.) Drury.	Sugandha kokila	Root	5000	Nepal
19	*Withania somnifera* Dunal	Ashogandha	Root	4035	Imported
20	*Zanthoxylum armatum* DC.	Timur	Fruit	4000	Nepal
21	*Commiphora mukul* Engl.	Gogul kora	Gum/resin	2700	Imported
22	*Cassia senna* L.	Sanayapati	Leaf	2600	Imported
23	*Gymnema sylvestre* R. Br.	Gudmar	Leaf	2520	Imported
24	*Glycyrrhiza glabra* L.	Jethimadhu	Root/stem	2500	Imported
25	*Litsea cubeba* (Lour.) Pers.	Siltimur	Fruit	2500	Nepal
26	*Morus nigra* L.	Mulberry	Leaf	2000	Nepal
27	*Eclipta prostrata* (L.) L.	Bhringaraj	Whole plant	1600	Imported
28	*Delphinium himalayai* Munz.	Atis	Root	1500	Nepal
29	*Tribulus terrestris* L.	Gochhur	Whole plant	1500	Nepal/imported
30	*Rhododendron arboreum* Sm.	Rohita	Bark	1480	Nepal
31	*Cyperus rotundus* L.	Mothe	Tuberous root	1400	Imported
32	*Pterocarpus santalinus* L. f.	Raktachandan	Wood	1250	Imported
33	*Asparagus racemosus* Willd.	Satawari, Kurilo	Root	1200	Nepal
34	*Valeriana jatamansii* Jones.	Sugandhawal	Root	1200	Nepal
35	*Creteva religiosa* Fors. f.	Baruntwak	Bark	1180	Imported
36	*Litsea glutinosa* (Lour.) C. B. Rob.	Atismahari	Whole plant	1058	Nepal
37	*Curcuma longa* Roxb.	Heledo	Rhizome	1000	Nepal
38	*Solanum surattense* Burm. f.	Kantakari	Fruit	1000	Nepal
39	*Rubia manjith R*oxb. ex Flem.	Majistha	Root	1000	Nepal
40	*Piper nigrum* L.	Marich	Fruit	1000	Imported

In one another study, considering the factors such as the availability of the plant resources, market value, ease of cultivation, annual export demand, legal protection status,

availability of local processing techniques, parts used in trade, threat/conservation status, range of distribution, regenerative/rotation period, ethnobotanical importance, social acceptance for promotion, quality improvement potentials, among the following well known medicinal plants [*Phyllanthus emblica* (amla), *Chamomilla matricaria, Piper longum* (pipla), *Mentha arvensis* (mentha), *Aegle marmelos* (bel), *Cymbopogon flexuosus* (lemongrass), *Cinnamomum glaucescens* (sugandhakokila), *Azadirachta indica* (neem), *Asparagus racemosus* (satawari), *Acorus calamus* (bojho), *Zanthoxylum armatum* (timur), *Cinnamomum tamala* (tejpat), *Swertia chirayita* (chiraito), *Sapindus mukorossi* (ritha), *Taxus wallichiana* (lauth salla), *Bergenia ciliata* (pakhanbed), *Gaultheria fragrantissima* (dhasingre), *Dioscorea deltoidea* (bhyakur), *Rubia manjith* (majitho), *Juglans regia* (okhar), *Valeriana jatamansii* (sugandhawal), *Rheum australe* (padamchal), *Nardostachys grandiflora* (jatamansi), *Aconitum spicatum* (bisjara), *Morchella conica* (gucchi chyau), *Aconitum heterophyllum* (atis), *Neopicrorhiza scrophulariiflora* (kutki), *Cordyceps sinensis* (yarsagumba), *Dactylorhiza hatagirea* (panchaunle) and *Podophyllum hexandrum* (laghupatra)], twelve medicinal plants were prioritized for their commercial potentials. They are amla, chamomile, pipla, mentha, from Terai; timur, tejpat, chiraito, ritha from Mid-hills and sugandhawal, padamchal, jatamansi, bisjara from High mountains (25).

2.8 Bioprospecting

Searching, gathering and obtaining genetic materials from the biological resources usually present in the biodiversity rich countries in the South in the pursuit of some economically useful products such as medicines constitute what is known as bioprospecting (49). Bioprospecting endeavor is thought to convert the indigenous genetic resources into economic goods. However, at the same time, there have been many talks about theft or attempted theft of the biological resources and associated traditional knowledge. Immediately cases of turmeric, neem, hoodia and others come to mind. Before going further details, let us see how one can protect own invention or discovery commonly called intellectual property. It is done through the process of patenting. By acquiring patent for an invention, the inventor obtains a set of exclusive rights on his or her invention for a fixed period of time. What makes an invention worthy of patent? There are three criteria to make an invention patentable. An invention must have utilities, novelty and non-obviousness. An object with utilities has functional value and can thus be beneficial. A novel invention is one which is not described or reported before anywhere so that so called "prior art" describing the invention is absent. Furthermore, even if the invention contains some new element (inventive step) from the most nearly similar things known, it must pass the test of non-obviousness. In other words, this inventive step should not be obvious to the people who have knowledge and experience in the subject. Let us see three cases of how attempted patenting of the traditional medical knowledges was foiled.

a) Turmeric case: In 1995, two Americans of Indian origin obtained patent for the wound healing properties of turmeric powder (*Curcuma longa*). It was claimed in the patent that application of turmeric at the site of an injury and/or its oral intake would promote the healing of the wound.


Turmeric (*Curcuma longa*) rhizome

Turmeric has been popular as a spice. Among its various traditional uses, its healing qualities were known since ages in the Indian subcontinent. The Centre for Scientific and Industrial Research (CSIR) of India decided to challenge the patent at the United States Patent and Trademark Office (USPTO). In spite of the fact that almost every household in the subcontinent had knowledge about healing properties of the turmeric, to find written documents to prove "prior art" for its efficacy was strenuous. Fortunately a careful search afforded 32 references describing healing properties of turmeric written in *Hindi*, *Urdu* and *Sanskrit*, some documents were as old as 100 years. Finding the claims in the patent as obvious, the USPTO withdrew the patent. The turmeric use in the wound healing as a traditional art was thus established.

b) Neem case: Indian farmers have been using water or alcohol extracts of the neem (*Azadirachta indica*) seeds or leaves to guard off the insects and bugs since time immemorial. W. R. Grace & Co., a multinational chemical corporation obtained a patent claiming the enhanced shelf life of an extract of neem seeds (50).


Neem (*Azadirachta indica*) tree

The news that a patent has been issued on a traditional use of an indigenous plant brought a huge uproar in India. The patent was challenged at the European Patent Office. Tremendous international support was generated in support of the Indian case. The century old farmer's knowledge and skill about its use as well as previous work of the Indian scientists on shelf life of the neem extracts were presented to the European Patent Office. The European Patent Office found W. R. Grace & Co.'s claim on the patent lacked non-obviousness and revoked the patent in 2002.

c) Hoodia case: In South Africa, certain bush people named the San used to eat the pulp of a cactus, Hoodia, (*Hoodia gordonii*) is to suppress the thirst and hunger when they went for long hunting trip. Getting cue from this, the Council for Scientific and Industrial Research (CSIR) of South Africa started doing research on this cactus. Eventually CSIR obtained the appetite suppressant compound named P57 from the cactus. The compound P57 was patented without acknowledging the traditional wisdom of the bush people (50). CSIR even at a time said that the San clan has already been extinct which obviously not the case was. CSIR licensed the compound P57 to the UK based pharmaceutical company, Phytopharm for further development and clinical trials. Phytopharm subleased the compound P57 to the pharmaceutical giant, Pfizer. Patenting of P57 sent shock waves to the San people who rightfully demanded their share on their common ancestral wisdom. The San clan received international support. A deal was struck. The San clan was promised of at least four payments of $ 30,000 during the clinical testing of P57. They

would also obtain profit share of 6% of the royalties if and when the drug comes to the market.

These three cases bring to the issues concerning the protection of indigenous and traditional knowledge, wisdom and practices. In this connection, there are two terms frequently used: bioprospecting and biopiracy (51). These two terms in a way are two sides of the same coin. Bioprospecting consists of the process of screening and extracting chemical compounds from the living organisms such as plants, animals and microorganisms in the hope that some useful leads will be obtained for potentially beneficial products such as new drugs. Developing countries in the South have a huge mine of the genetic resources and associated indigenous knowledge waiting to be tapped through the medium of bioprospecting; however, they lack the capital, infrastructure and technology. Pharmaceutical firms of the developed countries in the North have these resources. If both sides, biodiversity rich South and technology rich North, agree to share the projected benefits of bioprospecting, things will work out satisfactorily. At times, the pharmaceutical firms are found to think that given the high risk and cost associated with bioprospecting, they are entitled for greater share of profit. If this happens, the South will feel cheated. Therefore, the whole issue boils down to what should be the distribution of the benefits if, for example, a new drug is discovered from the plant and marketed. Actually, before 1992, the biological resources anywhere were considered common property of human kind. Scientists and researchers could virtually go to anywhere and collect biological samples without specific consent from the host country. However, things have changed with the implementation of the Convention of Biological Diversity (CBD) in 1992. With this convention, sovereign national right over the biological resources was recognized. Countries with rich biodiversity are made committed to (a) conserve their biodiversity (b), develop it for sustainable use and (c) share the benefits arising out of the utilization of these genetic resources. From the traditional knowledge point of view, article 8(j) of the Convention of Biological Diversity (CBD) deserves special mention. It calls upon the countries to (a) respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities (b), promote the wider application of this knowledge, these innovations and these practices with the approval and involvement of the holders of this knowledge and (c) encourage equitable sharing of the benefits arising from the use of such knowledge, innovations and practices. Furthermore, article 18.4 states that contracting parties should encourage and develop models of cooperation for development and use of technologies, including traditional and indigenous technologies.

After the promulgation of the Convention of Biological Diversity (CBD), for bioprospecting of the genetic resources, two things become imperative, informed consent of the host country and fair agreement on the benefit sharing. Before any bioprospecting endeavor takes place, the host country is required to ascertain which biological resource is being considered, from which locality, what will be done with the resource, what is the projected outcome and what benefits will be shared. Then only valid permission for the collection of the biological resource from the host country is granted. A fair agreement on benefit sharing between the bioprospecting agency and the host country on the likely benefits of the collected genetic material needs to be chalked out clearly. Benefits may take the form of support for conservation, acquisition of research equipments, transfer of technology, training of the personnel and the distribution of the royalties should the

biological material is converted to economically useful items such as drugs and comes to the market. If things work out this way, there is likelihood that bioprospecting will succeed. Not adhering to this, if profit out of the collected genetic material is made only by the bioprsospecting agencies, this would simply constitute what is known as biopiracy.

2.8.1 Traditional Knowledge

Traditional knowledge is humanity's socially and culturally shared experience, wisdom and education that exist in symbiotic and balanced harmony with their local environments. Traditional knowledge encompasses the knowledge, skill and information generated through age's long experience and education for the survival as well as for finding practical solutions for everyday problems. As the nature of the problems change, traditional knowledge is also being continuously modified and evolved. The knowledge is holistic and it represents wide spectrum of cultural, religious, political and commercial values. Traditional knowledge such as indigenous medical knowledge is usually not written and orally passed. This might give unscrupulous people to seek benefit from the traditional medical knowledge by putting some sort of "inventiveness" for patent for lack of "prior art". It is also found that whole community is the owner of the traditional knowledge. Patent cannot be applied on behalf of the whole community. Furthermore, applying for patent is not an easy job. It demands considerable skill and money. The traditional community may not be in the position to file the patent considering these constraints. Then, how to protect the traditional knowledge? There exist two types of protective mechanisms of the traditional knowledge, defensive and positive protections (52).

a) Defensive protection: It holds that intellectual property right of the traditional knowledge should not be allowed to given to any parties other than the people who are the custodian of the knowledge. Some countries and communities have begun to prepare database of their traditional knowledge so that it could act as 'prior art' and thus traditional knowledge could be saved from the hands of biopirators. It is not altogether problem free though. When the database or some other type of literature describing traditional knowledge will come out, once hidden knowledge becomes available to the public. In many instances, the custodians are fond of keeping their knowledge secret. With the publication of the database of the traditional knowledge, the knowledge becomes no longer secret. Such disclosure may bring into light the commercial values of the natural resources. Should this happen, the custodians may have hard time to protect or defend their natural resources from over exploitation from unscrupulous outsiders. It is also some times argued that with defensive protection, the economic zeal to improve upon existing thing or to discover new thing will fade away.

b) Positive protection: It holds that the custodians are provided with legal right to protect and promote their traditional knowledge. *Sui generis* regime (unique mechanisms for providing legal protection for holders of traditional knowledge) should be built in the national legislative rules for the protection and promotion of the traditional knowledge. The system will provide automatic ownership of the traditional knowledge to the custodians. With the intellectual property protected by a *sui generis* system, traditional

knowledge and associated genetic resources could be put into contractual agreement for the benefit of the custodians who own the traditional knowledge. The components in such systems are deemed flexible as regards to definitions, objectives, subject matter, titleholders etc. Because of which, they can be nationally and regionally tailor made. Some problems can be seen with this system as well. The indigenous people are seen to have made their own *sui generis* system under their customary laws. How to integrate them into national *sui generis* system may pose difficulties. Different countries have different modalities for *sui generis* system and one commonly agreed international system is difficult to come by. TRIPs (trade related intellectual property rights) agreement, that stipulate internationally agreeable patent laws for WTO (World Trade Organization) member countries, has inadequate provision for the protection of the traditional knowledge.

2.8.2 Intellectual Right Protection

Often question is asked in what ways natural products, traditional herbal medicine and herbal medicinal products can be protected by patent? The answer is that there could be three ways (53).

a) New compounds from nature: The living organisms of the nature have been a great source of useful medicines. Drugs discovered from nature abound. Useful drugs such as aspirin, quinine, vinblastine, vincristine, penicillin, taxol and others immediately come to the mind. The list is impressive. How important is the role of the natural products in drug discovery can be appreciated from the fact that during the period of 2003–2005, 20 new drugs either obtained or inspired from natural source have been introduced in the market (37). A new lead compound with interesting biological properties will be a good candidate for obtaining patent. Starting from a novel structure with unique biological activity, if further derivatives could be prepared to examine structure–activity relationship as well as if the mode of biological mechanism is revealed, this would constitute further plus points for patenting.

b) Known compounds from nature: If new attractive biological properties are found in already known compound, it stands good chances of getting patent. Through derivative and analogue preparations of such compound, its properties such as efficacy, toxicity reduction or pharmacokinetics property could be modified. Furthermore, shortened and efficient methods of isolation and purification processes of known compounds with proven medicinal efficacy are deemed patentable.

c) Herbal medicines and herbal medicinal products: As compared to the purified compounds obtained from nature, difficulties arise in patenting herbal medicines and herbal products. Origin of medicinal plant (same medicinal plant can grow in several countries) and dearth of database of herbal medicines and herbal products further complicate the matter (54). It is to be kept on mind that herbal medicines contain several ingredients in fixed amount in either extract form or as tincture or as powder or as capsule. In such formulation, equally important considerations are which parts (leaves or stems or barks or rhizome or root) of the plant are used in making the formulations. It is

possible to protect herbal medicine inventions in the following four ways.

i) Formulation patent: If new dosage form or for that matter if new technology is devised to accomplish the best healing property of the traditional medicinal formulation, it stands chance to get protected by formulation patent.

ii) Combination patent: Suppose a new herbal drug preparation for the treatment of a disease is prepared, to get it protected from combination patent, it is deemed imperative that that (i) it should contain changed ratio of the active ingredients and (ii) it should be more effective than the known formulation in terms of therapeutic efficacy, less side effects and some other pharmacokinetic parameters.

iii) Process patent: A newly developed inventive input in any of the following steps of herbal medicine preparation process is likely to render patentability qualities. Inventive input could be (a) on preparing herbal drugs (b), on preparing pharmaceutical preparation using herbal drugs or herbal drug preparations (c), on isolating active principles from herbal drugs which has been used in the pharmaceutical preparations (d), on preparing standardized fluid, solid extracts or powders or tinctures from herbal drugs (e), on granulating and drying process of standardized extract (f), on preventing moisture and microbial contamination of standardized extract (g), on removing trace amount of contaminants such as pesticides, toxins and surfactants from the plant materials (h), on increasing the production of standardized extract from herbal drugs (i), on decreasing the cost of preparation of standardized extracts from herbal drugs (j), on increasing the purity of the extracts obtained from herbal drug and (h) on decreasing side effect of herbal drugs (55).

iv) Patent for new indication: If a new therapeutic property of a known herbal drug or herbal medicine is discovered, the herbal drug or medicine is liable for patent application for new indication.

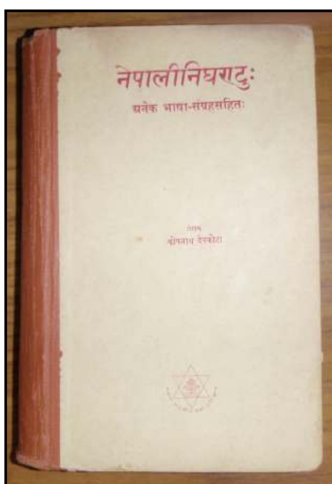
2.9 Nighantu (Medicinal Plant Book)

In strict sense, nighantu is a treatise where the words are collected and clustered into thematic categories with lucid description and some times with impressive illustrations. Medicinal nighantus are well known. Nighantu contains information regarding the medicinal plant, its therapeutic value as well as which part of the plant is to be collected, from where and when. It may be called some type of herbal pharmacopoeia. In Nepali context, three nighantu are worth mentioning. They are Saushrut nighantu, Bir nighantu and Nepali nighantu.

a) Saushrut Nighantu is perhaps the oldest Nepali medicinal plant book which was produced during the rule of the Great King Man Dev in the 5th century. It is made up of three volumes of which two are in the National Archives of Nepal and one is in Keshar library. It describes 278 plants in *Sanskrit* as well as 282 medicines (*drabyas*) for curing the illness. Nepal Sanskrit University published this nighantu in 2000.

b) Bir Nighantu has interesting story (56). During the tenure of the Rana Prime Minister Bir Shumshere (1885–1901), an Ayurvedic *kaviraj* Pundit Ghana Nath Devkota was

assigned to prepare Bir nighantu (Bir herbal pharmacopoeia). Pundit Devkota visited several places to collect the relevant information. Utilizing his profound knowledge and taking assistance from painters, the making of Bir nighantu went on. After the sudden death of Prime Minister Bir Shumshere, the project of writing Bir nighantu came to halt. The successor of Prime Minister Bir Shumshere, Chandra Shumshere took up the matter. Pundit Ghana Nath Devkota was summoned and once again commissioned to complete the nighantu. Several Indian professors as well as the experts from both Nepal and India joined hands to complete the nighantu. Because the nighantu was produced during the time of Prime Minister Chandra Shumshere, it is some times called Chandra nighantu. Bir nighantu is not yet published. Singha Durbar Vaidya Khana is in the possession of the Bir nighantu. It consists of 11 volumes of which 8 are botanical, 1 zoological, 1 minerals and 1 as subject index in about 1000 pages. Three languages, *Nepali*, *Newari* and *Sanskrit*, are used in the nighantu to describe the uses and properties of the medicinal plants. Beautiful color paintings of 750 plants and 90 animals totaling to 840 color plates are found in the Nighantu.



Nepali Nighantu Book

c) Nepali Nighantu is compiled by Mr. Koshnath Devkota, son of Pundit Ghana Nath Devkota. It was published by Nepal Academy in 1968. The nighantu contains 971 different articles classified under 28 major divisions. This division includes plants, animals, minerals, animal and meat products, cereals and plant products, poisonous and other toxic products, fats and oils, precious metals and minerals. The plants and other materials are named in *Sanskrit*, *Nepali*, *Newari*, Indian languages and *Latin*. At the end of the book, indices of the plants in different languages in alphabetical order are given.

2.10 Research, Development and Promotional Activities

There are several Government, academic and private organization involved in research, development and promotional activities of the medicinal and aromatic plants. The following are brief introduction of some of the major organizations.

a) Academic institutes

In the academic sector, four universities are one way or the other are in the medicinal and aromatic plant teaching and research. Tribhuvan University established in 1959 is the oldest and the largest university of Nepal. Its campuses are scattered throughout the country. It is the home of more than 200,000 students and more than 6000 faculty members. The major departments that are engaged in the medicinal and aromatic plants teaching and research in Tribhuvn university are Central Department of Chemistry, Central Department of Botany, Central Department of Mocrobiology, Central Department of Environmental Science, Tri-Chandra campus, Amrit Campus and Research Center for Applied Science and Technology (RECAST). One of the major research thrusts of Central Department of Chemistry has been chemical and biological work of Nepali medicinal plants. In Central Department of Chemistry, research work on the chemical and

biological work on the medicinal plants leading to PhD degree are going on. Central Department of Botany has been engaged in phytochemical, ecological and tissue culture works of some medicinal plants of interest. Furthermore, Central Department of Botany is involved in the preparation of data base of the medicinal and aromatic plants of Nepal. Research Center for Applied Science and Technology (RECAST) is one of four research centers of Tribhuvan university and is totally devoted to scientific and technological researches. RECAST has been active in chemical and biological studies of the medicinal plants. Kathmandu university is a private university established in 1990 and its pharmacy department runs programs in natural products teaching and research. Similarly, newly established universities such as Purubanchal University and Pokhara University have programs related to the medicinal plants studies and research. Nepal Sanskrit University has been cultivating medicinal plants since long time.

b) Nepal Academy of Science and Technology (NAST)

Nepal Academy of Science and Technology (NAST) is an autonomous apex body for the develpoment and promotion of science and technology in Nepal. Its medicinal and aromatic plants related activities include bioprospecting of the Himalayan medicinal plants and *in situ* conservation of germplasm of medicinal and aromatic plants, development of cultivation techniques and transfer of appropriate technology to the local people.

c) The Department of Plant Resources

Department of Plant Resources previously known as Department of Medicinal Plants was established in 1960. This institute is the leading Government body for providing services in research and development of the plant resources in the country. The major responsibilities of Department of Plant Resources include surveying and collecting of plant resources and preserving the specimens in the National Herbarium, maintaining botanical gardens, carrying out chemical and biological researches with an aim to optimum utilization of medicinal, aromatic and other plant resources, conducting biotechnology research to improve the plants of economic value and developing agro-technology on plants and providing services to the farmers on techniques of commercial cultivation of important medicinal and economic plants

d) The International Center for Integrated Mountain Development (ICIMOD)

Established to work towards economically and environmentally sound mountain development as well as to improve living standards of mountain communities, ICIMOD has taken over Medicinal and Aromatic Plants Program in Asia (MAPPA). MAPPA's activities are geared towards creating a system of long-term sustainable and equitable uses of the medicinal and aromatic plant resources in South Asia.

e) The Asia Network for Sustainable Agriculture and Bioresources (ANSAB)

The Asia Network for Sustainable Agriculture and Bioresources (ANSAB) is an independent, not for profit, international organization based in Kathmandu, Nepal established in 1992. Focusing on natural resource management and economic development, ANSAB is working towards sustainable use and management of non-timber forest products (NTFPs) supporting the development of viable community based forest enterprises.

f) Ethnobotanical Society of Nepal (ESON)
Taking the aim of enhancing the study and promoting the proper utilisation of plant resources in Nepal, a group of Nepali ethnobotanists established ESON (Ethnobotanical Society of Nepal) in 1997. ESON plans to promote plant based research activities through information exchange among plant scientists and institutions at national and international levels; increase public awareness on different issues related to indigenous knowledge and ensure intellectual property rights; strengthen community's capacity through training programs for both skill and leadership development and cultivate plants of medicinal and economic importance.

g) The World Conservation Union, IUCN, Nepal
Keeping the objectives to promote biodiversity conservation, environmental justice and sustainable livelihood, the World Conservation Union, IUCN, Nepal is in the conservation arena in Nepal since late 1960s. IUCN, Nepal published *National Register of Medicinal Plants* in 2000.

h) Jadi Buti Association of Nepal (JABAN)
Jadi Buti Association of Nepal (JABAN) was established in the city of Nepalgunj in western Nepal in 1995. In Nepalgunj, substantial trade of medicinal plant and herbs takes place. JABAN provides support to the rural communities for the medicinal plants cultivation. JABAN strives for the conservation of the natural resources. It works for the production of quality materials as well as prompt and efficient services & supply for the buyers.

i) Nepal Herbs and Herbal Products Association (NEHHPA)
Nepal Herbs and Herbal Products Association (NEHHPA) is a Kathmandu based association of herbal entrepreneurs. Advocating the advantages associated with herb and herbal business, NEHHPA intends to participate in the economic development of the nation through the medium of sustainable business of herbs and medicinal plants. It organizes herb related seminars and workshops, publishes a magazine *Prakrit* and advises on herb related issues to the Government agencies.

j) Nepal Traditional Ayurvedic Medicinal Practitioners Association
This association has membership of 55 traditional Ayurvedic practitioners and manufacturers from all over Nepal. The association aims to work towards passing valuable traditional practices to the new generations through well managed Ayurvedic institutions, campaign to generate awareness and knowledge about the efficacies of the herbs, reduce adulteration in the herb and herbal products and assist the Government for preparing and implementing the policies that address the conservation of traditional practices and the potential herbs.

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Chapter 3

Folk Medicines of Manang District

Plants used in the folk medicines have potentiality to afford useful modern drugs as they have done in the past. Myriad of valuable drugs must have been concealed inside these plants. These plants in a way are cultural and scientific treasures. Folk medicines are culturally preserved by ageless traditional wisdom waiting to be tapped by modern knowledge. Therefore, what is required is the examination of the plants in the realm of science.



Scenic Manang

Nepal is divided into seventy-five districts. Manang district (2000–6000 m) is one of them. Manang district with the population of 9,587 and an area of 2,246 km² is a part of the Gandaki zone. Manang district lies close to the Nepal-Tibet border. Manang district is remote, rugged and obviously serene & pristine. No motorable roads are available; it is accessed by small airplanes or by on foot. Modern health facilities are seriously lacking. All these make traditional health care delivery system a serious outlet for primary health care. Gurungs of the Tibetan origin form the main inhabitants of Manang district.

To illustrate how important folk medicinal plants are in terms of the chemical structure diversity and attractive biological properties, I will describe, in the next section, the traditional uses, principal chemical constituents and major biological activities of the ethnomedicinal plants used in Manang district. A recently published paper lists the traditional uses of ninety-one ethnomedicinal plants from Manang district. They were identified on the basis of extensive interviews with the professional Tibetan medicine practitioners called *Amchis*, local traditional healers called *Lamas* and the local elders. The plants and the traditional uses of the plants have been taken from this study (1). As regards to the location and distribution of the plants, most of the informations were sought and obtained from *Annoted Checklist of the Flowering Plants of Nepal* (2).

Abies spectabilis

Abies spectabilis (D. Don) Mirb. (Gurung language: *Kye*; Amchi term: *Thangwha*) belongs to the family Pinaceae. It is found in the Himalayan region (Chitral to central Nepal) at the elevation range of 2400 to 4000 meter.



Abies spectabilis

Traditional use in Manang

The paste obtained from fresh leaves and cones is applied on the fractured portion of the body. The patients suffering from fractured bones are also given decoction made by the cones and leaves.

Chemical constituents

Recently, two rearranged taxane type of compounds have been isolated from *A. spectabilis* (unpublished result) (3). The essential oil from the needles and tuigs of *A. spectabilis* contained α-pinene (3.0%), camphene (3.5%), β-pinene (5.1%), limonene (6.1%), bornyl acetate (4.2%) and carvone (5.8%) (4).

Biological properties

The methanol extract of *A. spectabilis* leaves had a moderate lipid peroxidation inhibition (IC_{50} = 30 μg/mL) suggesting that its protection against free radical induced lipid peroxidation might manifest its traditional use in the inflammatory diseases (5).

Aconitum naviculare

Aconitum naviculare (Bruhl) Stapf (Gurung language: *Bhalaponkar*) belongs to the family Ranunculaceae. It is found in the Himalayan region (Nepal to Bhutan) at around 4900 meter.



Aconitum naviculare

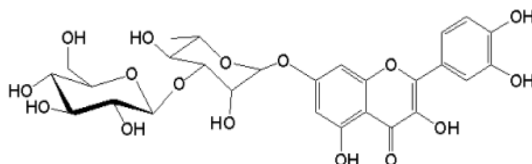
Traditional use in Manang

The decoction of the whole plant is useful for patients suffering from fever or jaundice. Tonic consisting of equal amount of *Cordyceps sinensis* (yartsagumba) and *Dactylorhiza hatagirea* (lovha) in cow's milk together with honey are also recommended to suppress any weakness resulting from the medication.

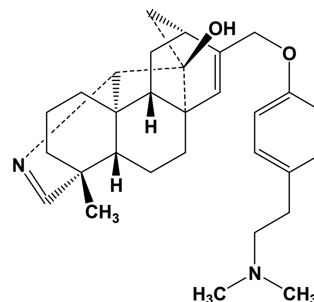
Chemical constituents

From this plant, favonoid glycosides namely 3-*O*-[β-D-glucopyranosyl-(1→3)- (4-*O*-*trans*-*p*-coumaroyl)-α-L-rhamnopyranosyl-(1→6)-β-D-glucopyranosyl]-7-*O*-[β-D-glucopyranosyl-(1→3)-α-L-rhamnopyranosyl]-kaempferol, 3-*O*-[β-D-glucopyranosyl-(1→3)-(4-*O*- *trans*-*p*-coumaroyl)-α-L-rhamno-

pyranosyl-(1→6)-β-D-glucopyranosyl]-7-*O*-[β-δ-glucopyranosyl-(1→3)α-L-rhamnopyra -nosyl]quercetin and 7-*O*-[β-D-glucopyranosyl-(1→3)-α-L- rhamnopyranosyl]quercetin (6) as well as diterpenoidal alkaloids such as navirine (7) and navirines B-C along with some phenol glycosides (8) have been obtained. The structures of representative isolated compounds are presented below.



7-*O*-[β-D-glucopyranosyl-(1→3)-α-L-rhamnopyranosyl]quercetin



navirine

Biological properties

A. naviculare forms a part of several patented Chinese traditional medicinal formulations. These include treatments for menstrual disorder (9), activating blood circulation, and expelling blood stasis (10), gynecological diseases (11) and hepatitis, cholecystitis and cholelithiasis (12).

Aconitum orochryseum

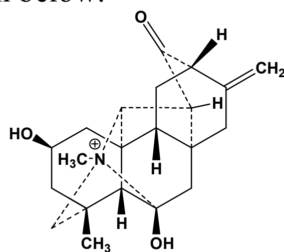
Aconitum orochryseum Stapf (Gurung language: *Nirmasi*) belongs to the family Ranunculaceae. It is found in the Himalayan region (Nepal to Bhutan) at the altitude range of 3600 to 4900 meter.

Traditional use in Manang

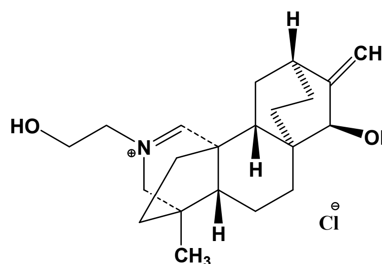
The plant is useful for fever, diarrhea, dysentery, cold & cough, tonsillitis, headache and high altitude sickness. The powdered root is taken with hot water. As in the case of *A. naviculare*, in order to avoid any weakness associated with the medication, tonic consisting of equal amount of *Cordyceps sinensis* and *Dactylorhiza hatagirea* in cow's milk together with honey is also taken.

Chemical constituents

From *A. orochryseum* collected from Bhutan, hetisine-type diterpenoid alkaloids such as orochrine, 2–*O*–acetylorochrine, 2–*O*–acetyl–7α–hydroxyorochrine, atisinium chloride and virescenine have been isolated (13). The structures of representative isolated alkaloids are given below.



orochrine



atisinium chloride

Biological properties

Antibacterial and antimalarial activities of the methanol extract and alkaloid fraction of *A. orochryseum* have been studied. The plant was found to be devoid of antibacterial properties. However, atisinium chloride, an alkaloid isolated from *A. orochryseum* was shown to be antimalarial (14).

Allium carolinianum

Allium carolinianum DC. (Gurung language: *Rotangtea*) belongs to the family Alliaceae. It is distributed in central Asia, Afghanistan and the Himalayan region (Kashmir to Nepal) at the elevation range of 4800 to 5100 meter.

Traditional use in Manang

Powdered whole plant is used as a spice in curry dishes. Eating such curry will be beneficial for stomachache, headache, diarrhea and dysentery. As a medicine, the powder is taken with hot water.

Chemical constituents and biological properties

Chemical and biological studies are lacking in this plant.

Allium fasciculatum

Allium fasciculatum Rendle (Gurung language: *Nosyante*) belongs to the family Alliaceae. It is distributed in the Himalayan region (Nepal to Bhutan) and Tibet at the elevation range of 2800 to 4500 meter.

Traditional use in Manang

Whole plant decoction is useful in the case of gastritis. The plant is also said to purify the blood.

Chemical constituents and biological properties

Chemical and biological studies are lacking in this plant.

Allium oreoprasum

Allium oreoprasum Schrenk (Gurung language: *Lungho*) belongs to the family Alliaceae. It is distributed in China (Xinjiang, western Xizang), Afghanistan, Kazakhstan, Kyrgyzstan, Pakistan, Tajikistan, Uzbekistan and Nepal at the elevation range of 1200 to 2700 meter.

Traditional use in Manang

Dried whole plant is cut into small pieces and is mixed with mustard oil. This paste is put in *dal* (a kind of lentil soup) or in some vegetable dishes. Eating these dishes would be beneficial for cold & cough, headache, tonsillitis and high altitude sickness. People

suffering from these diseases are advised to take powdered whole plant with hot water as well.

Chemical constituents
Chemical studies are lacking in this plant.

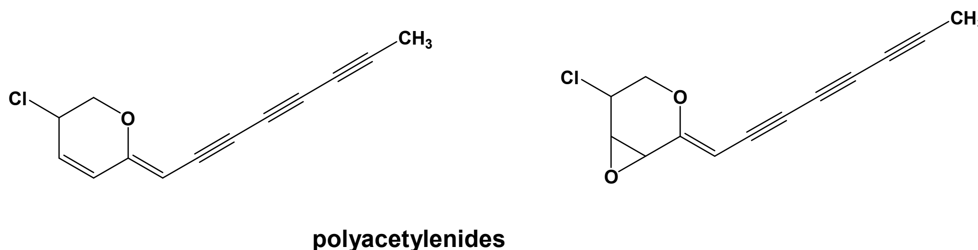
Biological properties
A. oreoprasum methanol extract has demonstrated strong antiviral activity (IC_{50} = 8 μg/mL) against influenza virus A (15).

Anaphalis triplinervis

Anaphalis triplinervis (Sims) C. B. Clarke (Gurung language: *Fojormendho*; Amchi term: *Tayung*) belongs to the family Compositae. It is distributed in India, Pakistan, Nepal, Bhutan and China at the elevation range of 1800 to 3500 meter.

Traditional use in Manang
The plant has several traditional uses. The dried powder is burned and the smokes are inhaled to cure cold & cough and tonsillitis. Water decoction is also used for the treatment of cold & cough and tonsillitis. Dried powder is also recommended for fever, menstrual disorder and edema. For persons suffering from inflamed and swollen body part, paste made from the leaves and flowers are topically applied. Moreover, the affected part is exposed to fire.

Chemical constituents
A group of polyacetylenides have been isolated from this plant (16). The structures of two isolated polyacetylenides are presented below.



polyacetylenides

Biological properties
Biological activity studies are lacking in this plant.

Androsace strigillosa

Androsace strigillosa Franch. (Gurung language: *Gadhikanakyo*) belongs to family Primulaceae. It is found in the Himalayan region of Nepal and Bhutan at the elevation range of 2400 to 4700 meter.

Traditional use in Manang
Powdered whole plant is taken with boiled water for edema and fever. Its paste has been used to cure skin swelling, a condition resulting from accumulation of water in the skin during cold season.

Chemical constituents
Chemical studies are lacking in this plant.

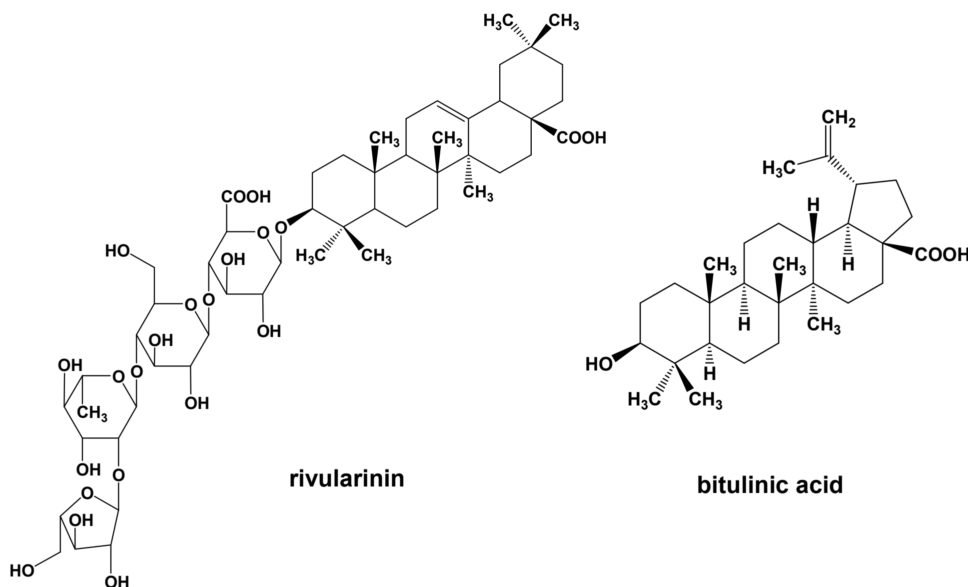
Biological properties
Its methanol extract is shown to contain strong antiviral (IC_{50} = 10 μg/mL) activity against influenza A virus (15).

Anemone rivularis

Anemone rivularis Buch.-Ham. ex DC. (Gurung language: *Angsoup*) belongs to the family Ranunculaceae. It is found in the Himalayan region, Tibet, India, Sri Lanka, Myanmar and north west China at the elevation range of 1600 to 4000 meter.

Traditional use in Manang
Powdered whole plant with boiled water is useful in cold & cough, stomachache, edema as well as in removing white intestinal worms.

Chemical constituents



Triterpene saponins are the major components of *A. rivularis*. Its roots and aerial part have afforded oleanolic acid 3-*O*-α-L-arabinopyranoside, oleanolic acid 3-*O*-α -L-rhamnopyranosyl(1→2)-α-L-arabinopyranoside, oleanolic acid 3-*O*-D-ribopyranosyl(1→3) -α -L-rhamnopyranosyl(1→2)-α-L-arabinopyranoside, hederagenin 3-*O*-α-L-arabinopyranoside, 3-*O*-α-D-ribopyranosyl(1→3)-α-L-rhamnopyranosyl(1→2) -α-L-arabinopyranosyl oleanolic acid 28-*O*-α-L-rhamnopyranosyl(1→4)-β-D-

glucopyranosyl(1→6)-*β*-D-glucopyranoside, 3-*O*-*α*-D-ribopyranosyl(1→3)-*α*-L-rhamnopyranosyl(1→2)-*α*-L-arabinopyranosyl hedera- genin 28-*O*-*α*-L-rhamnopyranosyl(1-4)-D-glucopyranosyl(1→6)-*β*-D-glucopyranoside, 3*β*,- 12*β*,23- trih- -ydroxy-olean-28,13*β*-olide and 3*β*,12*β*,13*β*-trihydroxy-olean-28-oic acid 3-*O*-D-ribopyranosyl(1→3)-α-L-rhamnopyranosyl(1-2)-α-L-arabinopyranoside (17). Anemoside A (18) rivularinin (19), huzhangosides A, B, C, and D (20) and bitulinic acid (21) have also been obtained from *A. rivularis*. The structures of rivularin and bitulinic acid are given in page 76.

Biological properties

Hederagenin3-*O*-[*β*-D-ribopyranosyl-(l→3)-*α*L-rhamnopyranosyl-(l→2)-*α*L-arabinoL-arabinopyranoside], a triterpene saponin isolated from *A. rivularis* is molluscicidal (22). The plant forms a part of the Chinese traditional medical formulations for the treatments of skin diseases (23) and throat infections (24).

Anisodus luridus

Anisodus luridus Link & Otto (Gurung language: *Langtang*) belongs to the family Solanaceae. It is found in Nepal, Bhutan, India, Sichuan and north west Yunan at the altitude range of 3200 to 4200 meter.



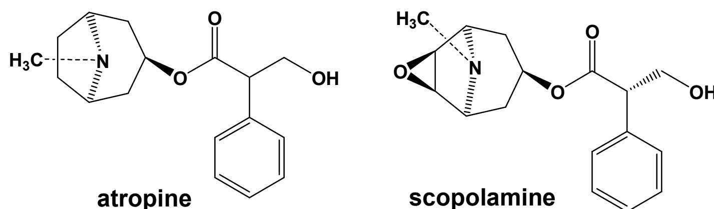
Anisodus luridus

Traditional use in Manang

Powdered dried flowers are mixed with cigarette tobacco. The mixture is smoked as a cigarette. By smoking this mixture, toothache and gingivitis are cured.

Chemical constituents

Two bioactive tropane alkaloids namely atropine (recemic hyoscyamine) and scopolamine have been obtained from *A. luridus.* Its root contains 1.9-2.8 percent alkaloid of which 18 percent is scopolamine (25). Hyoscyamine is said to be present 50 percent higher in *A. luridu*s roots than in belladonna plant (26). Structures of these two bioactive alkaloids are presented below.



Biological properties

Atropine is a well-known drug. It is used to dilate the pupil of the eyes. It functions as anticholinergic (27) and finds application in the treatment of condition of extreme low heart rate. It also acts as muscle relaxant and antispasmodic agent. Scopolamine too is an anticholinergic medicine. It finds applications in the treatment of nausea and motion

sickness, intestinal cramping, dilation of the pupils of the eyes and sedation before anesthetic procedure.

Arisaema flavum

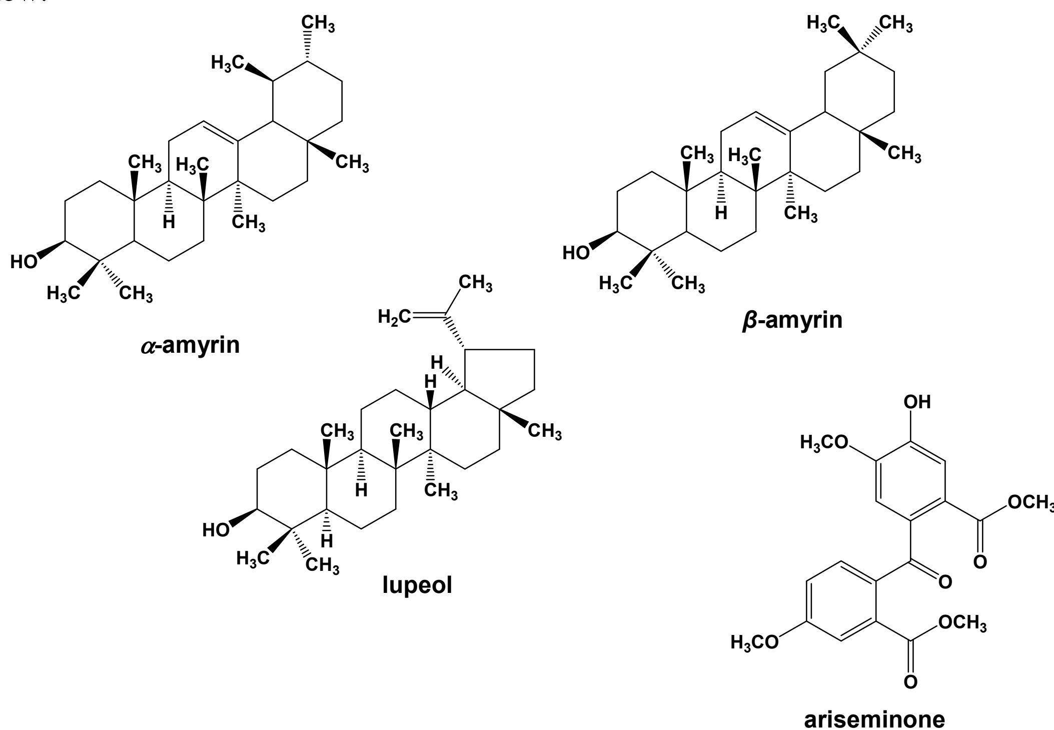
Arisaema flavum (Forssk.) Schott (Gurung language: *Timtry*; Amchi term: *Tangdhung*) belongs to the family Araceae. It is found in Afghanistan, the Himalayan region (Kashmir to Bhutan), south east Tibet and west China at the altitude of 2400 to 3800 meter.

Traditional use in Manang

Its root tuber is immersed in the ash of burning coal. A paste is made from this immersed part of the root tuber and is applied to skin diseases, wart, edema, wounds on the skin and vaginal infections.

Chemical constituents

From *A. flavum*, triterpenoids such as α-amyrin, β-amyrin, lupeol, lup-20(29)-en-3-β-yl acetate and sterols such as β-sitosterol, β-sitosteryl galactoside together with ariseminone have been isolated (28). The structures of representative isolated compounds are given below.



Biological properties

A lectin with specificity towards a complex glycoprotein asialofetuin has been purified from the tuber of *A. flavum*. This lectin demonstrated potent mitogenic activity towards BALB/c splenocytes and human lymphocytes in comparison to Con A, a well-known plant mitogen. It also displayed significant *in vitro* antiproliferative activity towards J774 and P388D1 murine cancer cell lines (29).

Arisaema jacquemontii

Arisaema jacquemontii Blume (Gurung language: *Thomo*; Amchi term: *Dhaba*) belongs to the family Araceae. It is found in Afghanistan, the Himalayan region (Kashmir to Bhutan), north Assam and south east Tibet at the elevation range of 2700 to 4000 meter.

Traditional use in Manang
Its root has been used to treat eye pain, nose (external and internal) pain and warts. The root is roasted. The roasted root is taken orally. Similarly, a paste is made from roasted root and is topically applied on the infected part**.**

Chemical constituents
Ariseminone is reported to have been obtained from this plant (30).

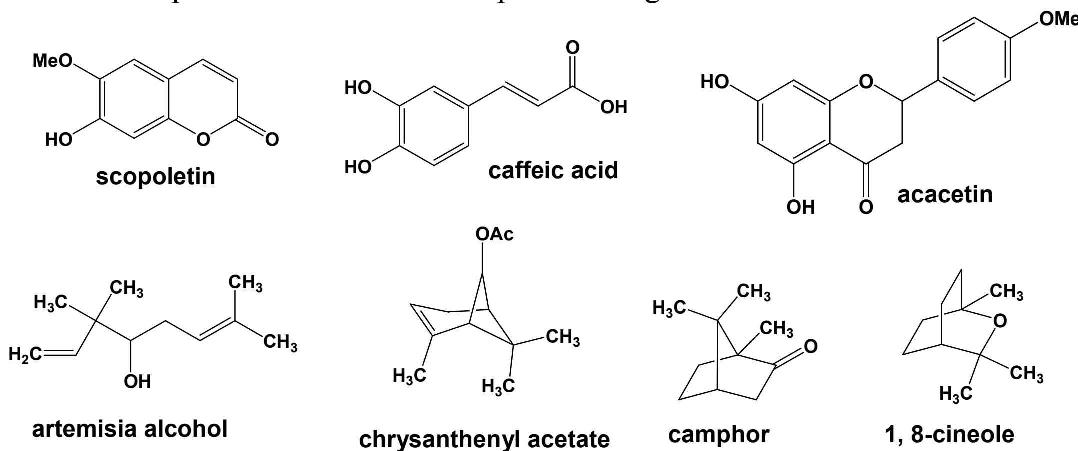
Biological properties
A lectin having appreciable insecticidal and antiproliferative activities has been purified from the tuber of *A. jacquemontii* (31).

Artemisia gmelinii

Artemisia gmelinii Weber ex Stechm. (Gurung language: *Bajha*) belongs to the family Compositae. It is distributed in Siberia, central Asia, the Himalayan region, Tibet, north China and Mongolia at the elevation range of 2800 to 3400 meter.

Traditional use in Manang
Decoction or powdered leaves, stems and flowers with hot water are taken for the treatment of cold & cough, fever and sore throat.

Chemical constituents
Phenolic compounds such as scopoletin, caffeic acid, 7,4'-dimethylapigenin, acacetin, 5,7,4'-trihydroxy-6,3'-dimethoxyflavone and velutin have been obtained from the aerial parts of *A. gmelinii* (32). Eudesmanolide and guaianolide types of sesquiterpenes were also found in *A. gmelinii* (33). Its essential oil is reported to contain yomogi alcohol, 1, 8-cineole, camphor, borneol, artemisia alcohol and chrysanthenyl acetate (34). The structures of representative isolated compounds are given below.



Biological properties

Essential oil of *A. gmelinii* is found to inhibit mycelial grouth of *Alternaria brassicicola,* a fungal casual agent of leaf spot disease of cabbage (35).

Asparagus filicinus

Asparagus filicinus Buch.-Ham. ex D. Don (Gurung language: *Nirshing*) belongs to the family Liliaceae. It is found in the Himalayan region (Kashmir to Bhutan), Assam, Myanmar, Thailand, Indochina and China at the elevation range of 2100 to 2900 meter.



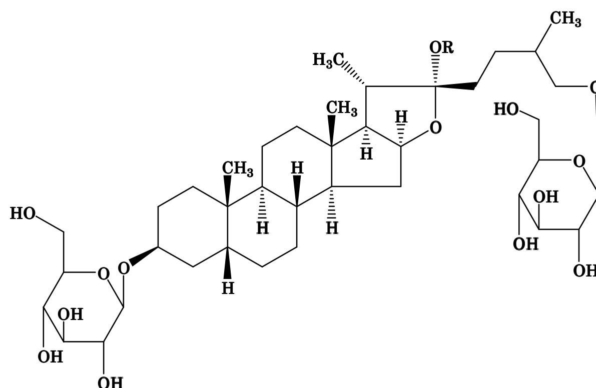
Asparagus filicinus

Traditional use in Manang

Powdered root in hot water or milk is considered a tonic. It helps increase body size. The same preparation is useful for menstrual disorder, heart disease and stomachache. The root paste is effective against skin diseases.

Chemical constituents

A. filicinus is rich in steroidal saponins. Its root has afforded steroidal saponins, filiasparosides A–D (36) aspafiliosides A, B and C (37) and aspafilioside D (38). An enolate derivative of furostanol glycoside, named asparagusin A also was isolated from the roots of *A. filicinus* (39). Furthermore, furostanosides such as filicinoside A, filicinoside B (40) and filicinoside C, filicinoside D along with oligospirostanosides filicinin A and filicinin B have been isolated from the ethanol extract of the roots of *A. filicinus* (41). Besides such steroidal saponins, ecdysteroids such as β-ecdysterone, 25-hydroxydacryhainansterone, stachysterone B, 5-deoxykaladasterone, calonysterone; two lignans like (+)-nyasol and syringaresinol-4'-*O*-β-D-glucopyranoside; one phenylpropanoide 1-*O*-feruloyl glycerol as well as β-sitosterol and β-daucosterol were also obtained from the chloroform fraction of the plant (42). The structures of filicinosides A and B are presented below.



filicinoside A R = CH_3
filicinoside B R = H

Biological properties

Steriodal saponins such as filiasparosides A–D and aspafiliosides A–B are found to be cytotoxic against human lung carcinoma (A549) and breast adenocarcinoma (MCF-7) tumor cell lines. Filiasparoside C showed potent cytotoxicity towards A549 (EC_{50} = 2.3 μg/mL) and MCF-7 (EC_{50} = 3.0 μg/mL) cell lines (36). Asparagusin A displayed cytotoxic activity effect on PC12 cells (39). A composition of *A. filicinus* steroidal saponins having EC_{50} value of 2.3 μg/mL against human lung cancer (A549) cell line and EC_{50} value of 3.6 μg/mL against breast cancer (MCF-7) cell line has been patented (43). The methanol extract of *A. filicinus* contained significant antiviral activity (EC_{50} = 6.25 μg/mL) against influenza A virus (15).

Aster diplostephioides

Aster diplostephioides (DC.) C. B. Clarke (Gurung language: *Mara*; Amchi term: *Motolugmick*) belongs to the family Asteraceae. It is found in the Himalayan region (Kashmir to Bhutan), Tibet and western China at the elevation range of 3200 to 4900 meter.

Traditional use in Manang

Either flower decoction or powdered flower with hot water is useful for cold & cough, headache, tonsillitis, sore throat, chest pain, back pain, pulse pain, limb numbness, snakebite and scorpion sting.

Chemical constituents and biological properties

Chemical and biological studies are lacking in this plant.

Aster stracheyi

Aster stracheyi Hook. f. (Gurung language: *Mara*) belongs to the family Asteraceae. It is found in the Himalayan region (Kulu to Bhutan) at the elevation range of 2900-4700 meter.

Traditional use in Manang

Powdered flower or powdered dried whole plant is mixed either with boiled water or with milk. This is orally taken for cold & cough, headache and fever.

Chemical constituents and biological properties

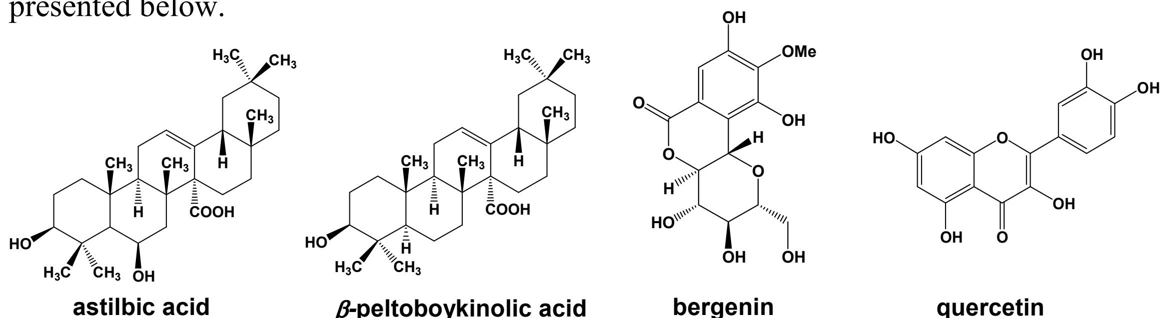
Chemical and biological studies are lacking in this plant.

Astilbe rivularis

Astilbe rivularis Buch.-Ham. ex D. Don (Nepali language: *Bhadhangoo*) belongs to the family Saxifragaceae. It is distributed in Nepal, Bhutan, north India, Indonesia, Laos, north Myanmar, Thailand and Vietnam at the altitude around 1500 meter.

Traditional use in Manang
Root powder is taken either with hot water or with milk for symptoms related to fever, vertigo/dizziness, headache and infertility.

Chemical constituents
The aerial part of *A. rivularis* is found to contain bergenin together with β-amyrin, β-sitosterol, β-peltoboykinolic acid, astilbic acid and quercetin (44). From the rhizome of *A. rivularis*, β-peltoboykinolic acid, astilbic acid, acetyl-β-peltoboykinolic acid and bergenin have been isolated (45). The structures of representative isolated compounds are presented below.



Biological properties
Bergenin isolated from Astilbe as well as from some other plant species is a well-known bioactive compound. Bergenin contains anti-inflammatory, analgesic, antifeedant, antiarrhythmic, hepatoprotective, antiulcer, hypolipidemic, antioxidant, antipyretic and antitussive properties (46). The methanol extract of *A. rivularis* is shown to contain potent antiviral activities against herpes simplex virus type 1 as well as against influenza virus A (EC_{50} = < 6.25 μg/mL in both virus types) (15).

Berberis angulosa

Berberis angulosa Wall. ex Hook f. & Thomson (Gurung language: *Kyunudzu*) belongs to family Berberidaceae. It is found in the eastern Himalayan region (Nepal, Sikkim, Assam) and south east Tibet at the elevation range of 3400 to 4500 meter.

Traditional use in Manang
Its powdered root is boiled with water and is drunk to get relief from cold & cough, fever and dysentery. Alternatively, root powder is mixed with milk and is orally taken.

Chemical constituents
Occurrence of berberine is reported from this plant (47).

Biological properties
Berberine is a well-known drug and finds application in the treatment of arrhythmia, severe cardiac failure, hypertension, hyperlipidemia, diabetes, peptic gastric ulcer and gastritis and chronic cholecystitis (48).

Berberis aristata

Berberis aristata DC. (Gurung language: *Karya*) belongs to the family Berberidaceae. It is found in the sub-Himalayan tract at the altitude range of 850 to 2500 meter as well as at Nilgiri and Sri Lanka.



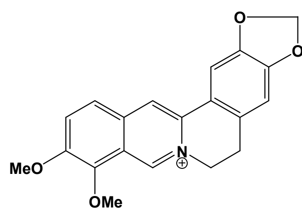
Berberis aristata

Traditional use in Manang

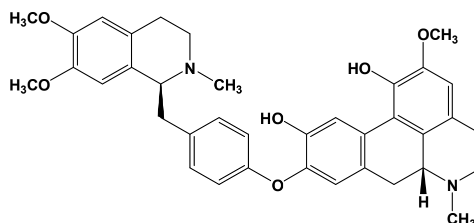
Paste of flower, leaves and bark is applied to cure edema. Furthermore, purified decoction of flower parts is used for eye diseases (conjunctivitis and other infections).

Chemical constituents

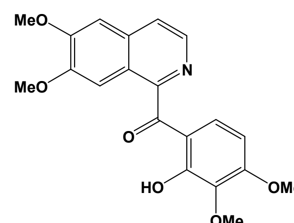
A bioactive isoquinolene alkaloid, berberine, is found in roots, rhizome and stem bark of *B. aristata*. The root bark contained along with berberine other alkaloids such as aromoline, oxyberberine, oxyacanthine and berbamine (49). It has also afforded some other alkaloids such as karachine (50) taxilamine (51) and pakistanine, 1-*O*-methylpakistanine, pseudopalmatine chloride and pseudoberberine chloride (52). Polyphenols such as caffeic acid, quercetin, rutin, chlorogenic acid, and meratin were identified in *B. aristata* flowers (53). The structures of isolated representative alkaloids are presented below.



berberine



pakistanine



taxilamine

Biological properties

Berberine has a long history of medicinal use in both Ayurvedic and Chinese medicine. Berberine extracts and decoctions have demonstrated significant antimicrobial activity against a variety of organisms including bacteria, viruses, fungi, protozoans, helminthes and chlamydia. Berberine finds major clinical uses in bacterial diarrhea, intestinal parasite infections and ocular trachoma infections (54). Furthermore, berberine displayed antidepressant activity (55) and inhibitory effects on potassium and calcium currents in isolated rat hepatocytes indicating its role in hepatoprotection (56). Berberine offered protection against chemical carcinogenesis (57). Berberine selectively inhibited collagen-induced platelet aggregation (58). Berberine is found to inhibit intestinal secretory response of *Vibrio cholerae* and *Escherichia coli* enterotoxins (59).

Berberis ceratophylla

Berberis ceratophylla G. Don (Gurung language: *Kyerpa*) belongs to the family Berberidaceae. It is found in the Himalayan region (Nepal to Bhutan) and Myanmar at the elevation range of 1800 to 4000 meter.

Traditional use in Manang

Powdered bark is mixed with boiled water. It is taken with milk to get relief from fever. Alternatively, powdered bark is mixed with yak (*chauri*) ghee (clarified butter without any solid milk particles or water).

Chemical constituents and biological properties

Chemical and biological studies are lacking in this plant.

Bergenia ciliata

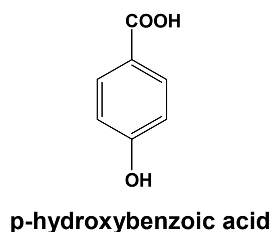
Bergenia ciliata (Haw.) Sternb. (Gurung language: *Pakhanved*; Amchi term: *Khadur*) belongs to family Saxifragaceae. It is found in the Himalayn region at the elevation range of 1900 to 2600 meter.

Traditional use in Manang

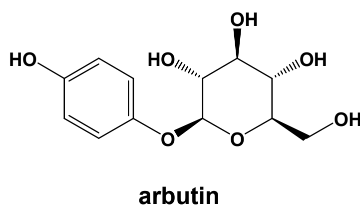
Powdered root is taken with hot water for conditions related to diarrhea, dysentery, stomachache and blindness.

Chemical constituents

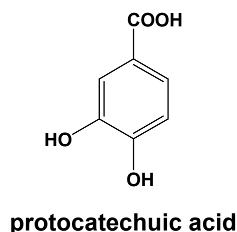
Phenolic compounds such as *p*-hydroxybenzoic acid, protocatechuic acid, arbutin, (+)-catechin, (+)-afzelechin, 6-*O*-protocatechuoylarbutin, 11-*O*-*p*-hydroxybenzoylbergenin, 11-*O*-protocatechuoylbergenin, 6'-*O*-*p*-hydroxybenzoyl- parasorboside, quercetin-3-*O*-β-D-xylopyranoside, quercetin- 3-*O*-α-L-arabinofuranoside, eriodictyol -7-*O*-β-D-glucopyranoside, 6'-*O*-*p*-hydroxy- benzoylarbutin, bergenin, 4-*O*-galloybergenin and 11-*O*-galloylbergenin have been obtained from the rhizome of *B. ciliata* (60). The structures of representative isolated compounds are presented below.



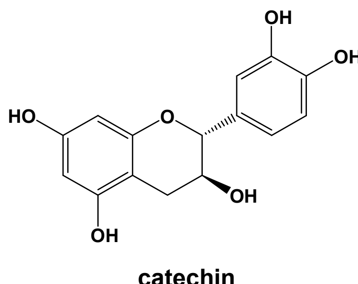
p-hydroxybenzoic acid



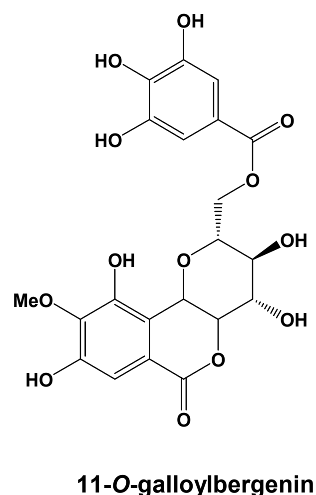
arbutin



protocatechuic acid



catechin



11-*O*-galloylbergenin

Biological properties

Aqueous extract of *B. ciliata* rhizome demonstrated significant antibacterial activity (61). The rhizome aqueous or methanol extracts are found to be gastroprotective on ethanol/HCl, indomethacin and pylorus ligation induced gastric ulcers in rats (62). The methanol extract is also shown to be antitissusive (63), antipyretic (64) and anti-inflammatory (65). Two catechins isolated from *B. ciliata* namely, (-)-3-*O*-galloylepicatechin and (-)-3-*O*-galloylcatechin, demonstrated significant dose dependent enzyme inhibitory activities against rat intestinal α-glucosidase and porcine pancreatic α-amylase displaying the antidiabetic potential of the plant (66). In addition, methanol extract of *B. ciliata* contained potent antiviral properties against herpes simplex virus type 1 (EC_{50} = < 6.25 μg/mL) and influenza virus A (EC_{50} = 9 μg/mL) (15). The plant forms a part of patented herbal preparations such as α–glucosidase inhibitors (useful for the treatment of diabetes mellitus, obesity and viral infections) (67), matrix metallo proteins inhibitors (useful for preventing or treating skin aging) (68) and skin conditioning cosmetics containing peroxide scavengers and inhibitors of elastase and collagenase (69).

Betula utilis

Betula utilis D. Don (Gurung language: *Buspath*) belongs to the family Betulaceae. It is found in Afghanistan and the Himalayan region (Kashmir to Bhutan) at the elevation range of 3000 to 4500 meter.



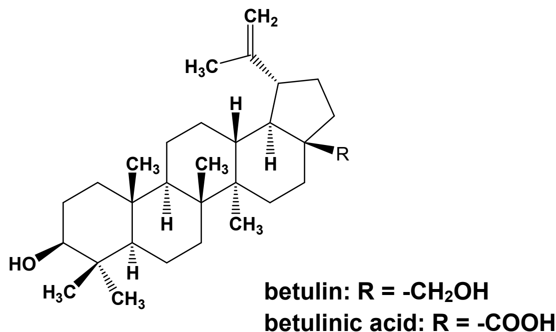
Betula utilis

Traditional use in Manang

Bark and leaves are made powder and mixed with other herbs (unknown). This mixture is taken with cow ghee for the relief of the fever.

Chemical constituents

B. utilis bark is rich in triterpenes. The bark is shown to contain betulin, lupeol, oleanolic acid, acetyloleanolic acid, leucocyanidin (70), betulinic acid, lupenone, methyl betulonate and methyl betulate (71) and karachic acid (72). Its volatile fraction is found to be mostly composed of sesquiterpenes (73). The structures of betulin and betulinic acid are presented below.



Biological properties
Betulin and more importantly betulinic acid & its derivatives are shown to contain diverse biological properties such as cytotoxicity, antibacterial, antiviral, anti-inflammatory, anti HIV and antimalarial (74). Betulin is also said to possess anti-snake venom property (75).

Bistorta affinis



Bistorta affinis

Bistorta affinis (D. Don) Green (Gurung language: *Khaldi*) belongs to the family Polygonaceae. It is found in Afghanistan, the Himalayan region (Kashmir to Nepal) and Tibet at the altitude range of 3500 to 4800 meter.

Traditional use in Manang
Pulverized or powdered root is boiled with water and is taken orally for the symptoms of cold & cough, tonsillitis and fever.

Chemical constituents and biological properties
Chemical and biological studies are lacking in this plant.

Bistorta macrophylla

Bistorta macrophylla (D. Don) Sojak (Gurung language: *Khaldi*) belongs to the family Polygonaceae. It is distributed in the Himalayan region (Garhwal to Bhutan) at the altitude range of 2700 to 4500 meter.

Traditional use in Manang
Pulverized or powdered root is boiled with water and is taken orally for curing typhoid fever.

Chemical constituents and biological properties
Chemical and biological studies are lacking in this plant.

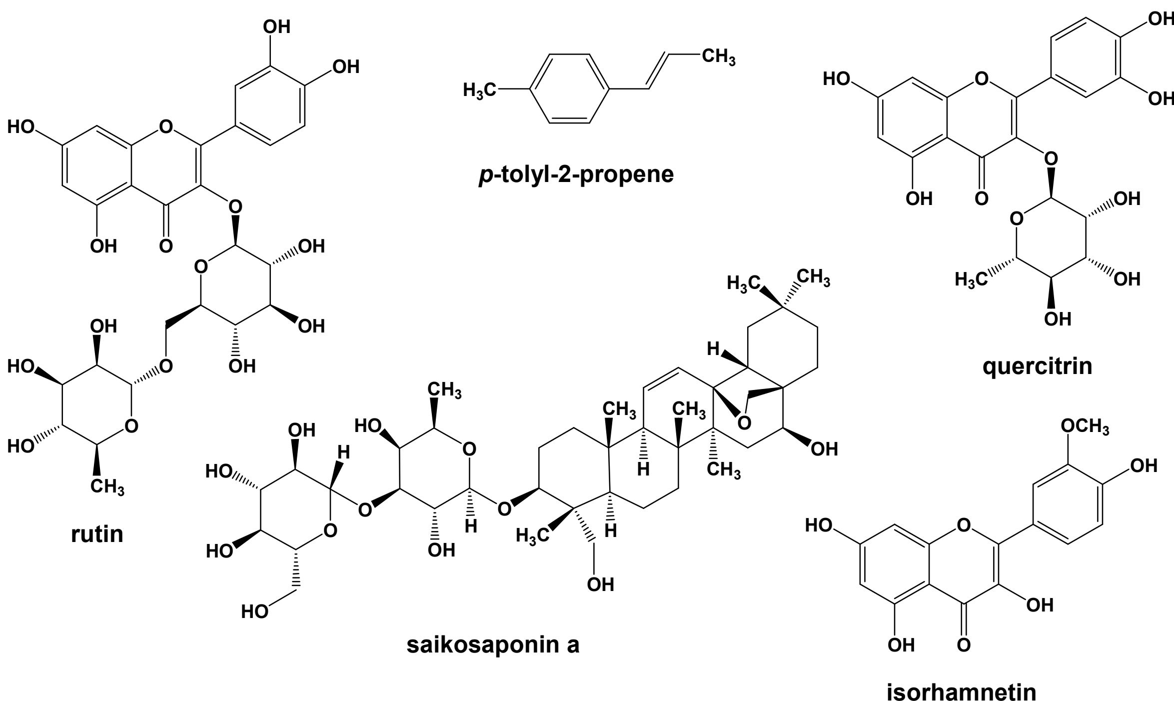
Bupleurum longicaule

Bupleurum longicaule Wall. ex DC. (Gurung language: *Mirmire*) belongs to the family Apiaceae. It is found in the Himalayan region (Kashmir to Bhutan) and Tibet at the elevation range of 3300 to 4900 meter.

Traditional use in Manang
Its flower and seeds are boiled with water. The decoction is taken orally for the symptoms of cold & cough and tonsillitis.

Chemical constituents

*B. longicaul*e root contains saikosaponins. The roots of *B. longicaule* var. *franchetii* is shown to possess saikosaponins a–d, 2''-*O*-acetylsaikosaponin a, 3''-*O*-acetylsaikosaponin a, 3''-*O*-acetylsaikosaponin d, 6''-*O*-acetylsaikosaponin a and 6''-*O*-acetylsaikosaponin d (76). In the roots of *B. longicaul*e var. *himalayense*, saikosaponins a–c were detected (77). Flavonoids such as rutin, narissin, quercitrin and isorhamnetin have also been isolated from *B. longicaul*e Wall. ex DC. var. *giraldii* Wolff (78). Nineteen compounds were characterized in the essential oil obtained from the root of *B. longicaul*e with hexanal (15.1%), furfural (15.6%) and *p*-tolyl-2-propene (7.2%) as main constituents (79). The structures of representative isolated compounds are given below.



Biological properties

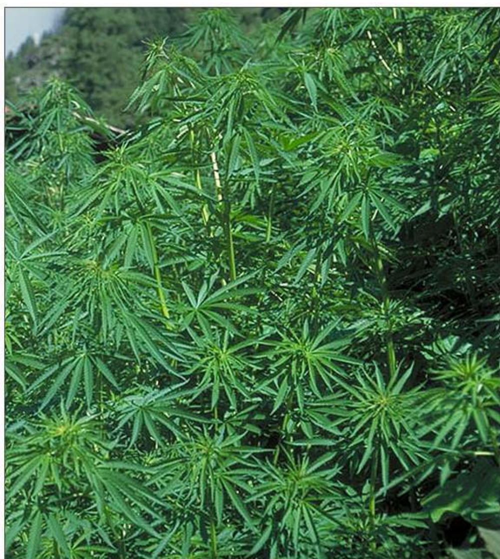
Saikosaponins are bioactive compounds. They are shown to possess antiviral (80), anti-inflammatory (81), hepatoprotective (82) properties and are useful in kidney diseases (83).

Cannabis sativa

Cannabis sativa L. (Gurung language: *Kantsya*) belongs to the family Cannabaceae. It is found at the elevation range of 200 to 2700 meter. The plant is thought to be the native of central Asia but it is widely cultivated and naturalized in temperate and tropical areas.

Traditional use in Manang

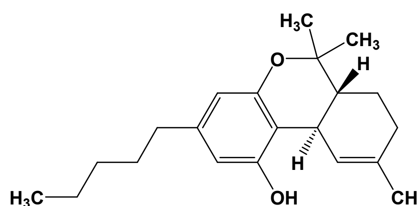
Powdered seeds together with a pinch of flower are taken with boiled water for the remedy of constipation, stomachache and urinary tract infection. Overdose of this tea may produce dizziness.



Cannabis sativa

Chemical constituents

Various classes of chemical compounds such as mono- and sesquiterpenes, sugars, hydrocarbons, steroids, flavonoids, nitrogenous compounds, amino acids and others have been found in *C. sativa*. The famous psychologically active class of the compounds isolated belongs to C_{21} terpenophenolic cannabinoids of which (−)-Δ^9-*trans*-(6a*R*,10a*R*)-tetrahydrocannabinol (Δ^9-THC) is the best known. A large number of cannabinoids including their analogs and transformation products have been isolated (84), (85). The structure of Δ^9-THC is written below.



(−)-Δ^9-*trans*-(6a*R*,10a*R*)-tetrahydrocannabinol (Δ^9-THC)

Biological properties

C. sativa has a long history of recreational and medical uses (86). Cannabinoids are described as having therapeutic potential as antiemetics, appetite stimulants in debilitating diseases (cancer and AIDS), analgesics, and in the treatment of multiple sclerosis, spinal cord injuries, Tourette's syndrome, epilepsy and glaucoma (87). Cannabinolds have been found moderately effective in clinical trials of multiple sclerosis, traumatic brain injury, arthritis and neuropathic pain. In addition, they have shown efficacy in other inflammatory diseases such as inflammatory bowel disease, Alzheimer's disease, atherosclerosis, and osteoporosis (88).

Caragana brevispina

Caragana brevispina Royle (Gurung language: *Momosing*) belongs to the family Leguminosae. It is distributed in east Asia and north western Himalayan region at the altitude range of 1500 to 2700 meter.

Traditional use in Manang

Powdered stem is taken for the conditions related to cold & cough, skin diseases, heart pain and defects in vision.

Chemical constituents and biological properties

Chemical and biological studies are lacking in this plant.

Carum carvi

Carum carvi L. (Gurung language: *Chir*) belongs to the family Umbelliferae. This herb is said to be native of Europe and west Asia. It is found in Karakorum, the Himalayan region (Kashmir to Bhutan) and Tibet at the elevation range of 2500 to 5100 meter.



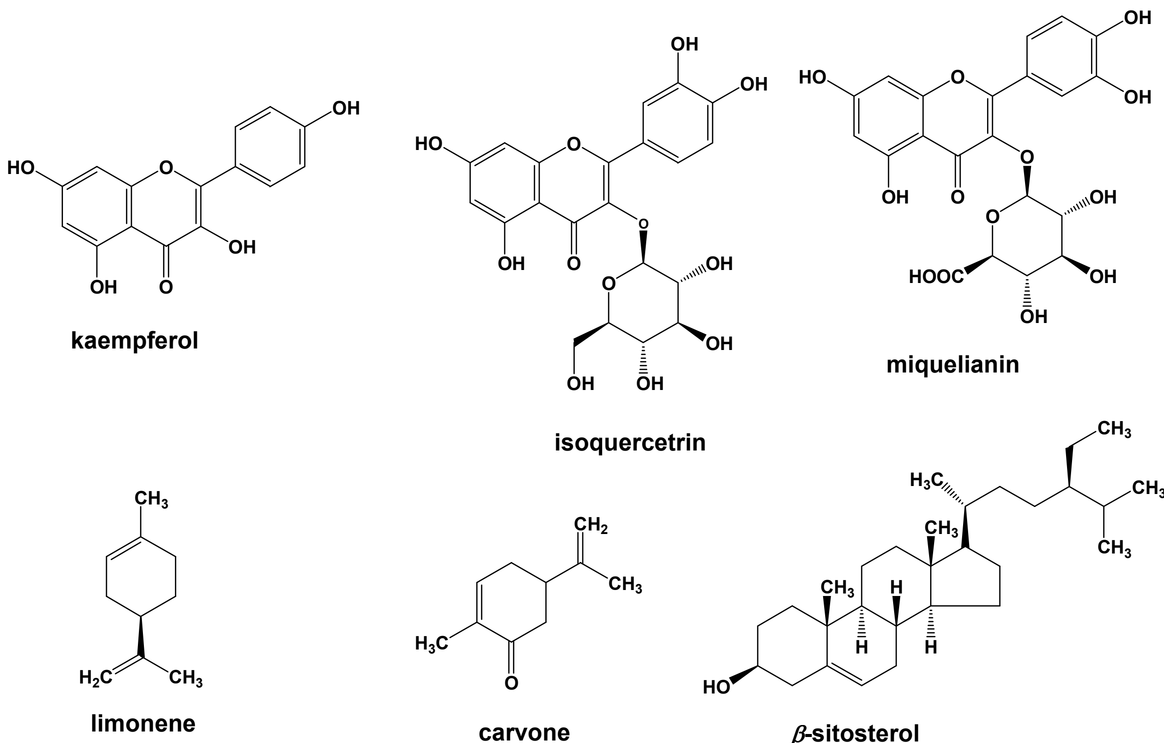
***Carum carvi* fruits**

Traditional use in Manang

Seeds are pounded on a stone slab and the pounded seeds are boiled with water. The decoction is drunk for the relief of cold and cough. Infants are massaged on the forehead and body with mustard oil boiled with the seeds of *C. carvi*.

Chemical constituents

Phenolic compounds such as kaempferol, caffeic acid, astragalin, isoquercetrin, hyperoside and miquelianin have been isolated from the flowers of *C. carvi*. Sterols such as stigmasterol, campesterol and *β*-sitosterol were also detected. Linoleic acid is found to be the major fatty acid present in the flowers of *C. carvi* (89). One another flavonol glycoside, quercetin 3-*O*-caffeyl-glucoside has also been obtained from *C. carvi* (90). Carvone (60%) and limonene (35%) were the principal constituents of the essential oil of the seeds of *C. carvi* (91). *C. carvi* essential oil collected from the Kumaon region of India had carvone as the major constituent (81.5%) followed by citronellyl acetate, dihydro carvone, eugenol, isolimonene, limonene oxide, Δ^3-carene, camphene, caryophylline, carveol, *p*-cymene, dihydrocarveol, linalool, *p*-mentha-2, 8 dienl-ol, myrcene, *α*-pinene, *β*-pinene, phellandrene, sabinene, *α*-terpinene and terpinelene (92). The structures of representative isolated compounds are presented below.



Biological properties

C. carvi essential oil is antibacterial (93), hypoglycemic and hypocholesterolemic (94), cancer chemopreventive (95) and molluscicidal (96). *C. carvi* had a modulatory role on tissue lipid peroxidation and prevented 1,2-dimethylhydrazine induced histopathological lesions in colon cancer in rats (97). *C. carvi* also decreased aberrant crypt foci development and the levels of fecal bile acids, neutral sterols as well as tissue alkaline phosphatase activity activities in 1,2-dimethylhydrazine induced colon cancer rats showing its potentiality of inhibiting tumorigenesis (98).

Cicerbita macrorhiza

Cicerbita macrorhiza (Royle) Beauv. (Gurung language: *Mendho*) belongs to the family Compositae. It is distributed in the north west Pakistan, the Himalayan region (Kashmir to Bhutan), south Tibet, Myanmar and south west China at the elevation range of 1300 to 4500 meter.

Traditional use in Manang

Its chopped roots are cooked with wheat flour and water. This cooked food is given to the animals for the treatment of fever.

Chemical constituents and biological properties

Chemical and biological studies are lacking in this plant.

Clematis barbellata

Clematis barbellata Edgew. (Gurung language: *Kramay*) belongs to the family Ranunculaceae. It is found in the Himalayan region (Kashmir to Nepal) at the altitude range of 3000 to 3200 meter.

Traditional use in Manang

The paste of leaves and flowers is topically applied around boils, cuts, wounds as well as hand and leg fractures. Massaging with this paste relieves back and waist pains. Powdered leaves and flowers are orally taken for cold & cough and body pain.

Chemical constituents and biological properties

Chemical and biological studies are lacking in this plant.

Clematis tibetana

Clematis tibetana Kuntze (Gurung language: *Damongnakyo*) belongs to the family Ranunculaceae. It is distributed in the Himalayan region (Garhwal to Nepal) and south east Tibet at the elevation range of 1700 to 4000 meter.



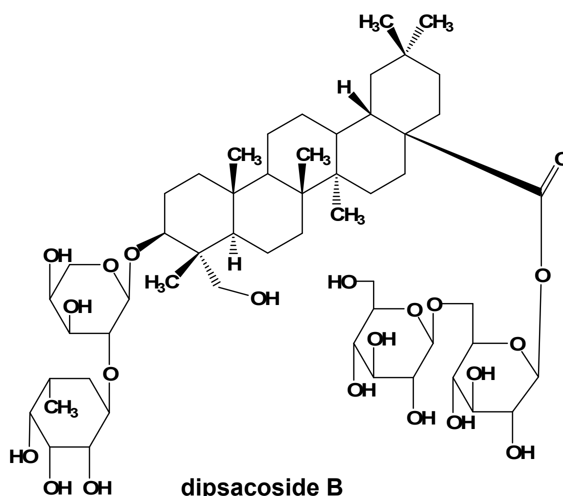
Clematis tibetana

Traditional use in Manang

Powdered stem, leaves and flower are taken with hot water for the condition of cold & cough and tonsillitis. The paste made up from stem, leaves and flower is applied on the wounds as well.

Chemical constituents

The plant contains triterpene saponins. Two hederagenin 3,28-*O*-bisdesmosides named as clematibetosides A and C and a gypsogenin named as clematibetoside B, have been isolated together with other saponins such as huzhangoside D, hederasaponin C, CP_6, HN saponin H, kizutasaponin K_{10}, CP_8 and dipsacoside B from the aerial part of *C. tibetana* (99). The structure of dipsacoside B is presented below.



Biological properties

Biological activity studies are lacking in this plant.

Clinopodium umbrosum

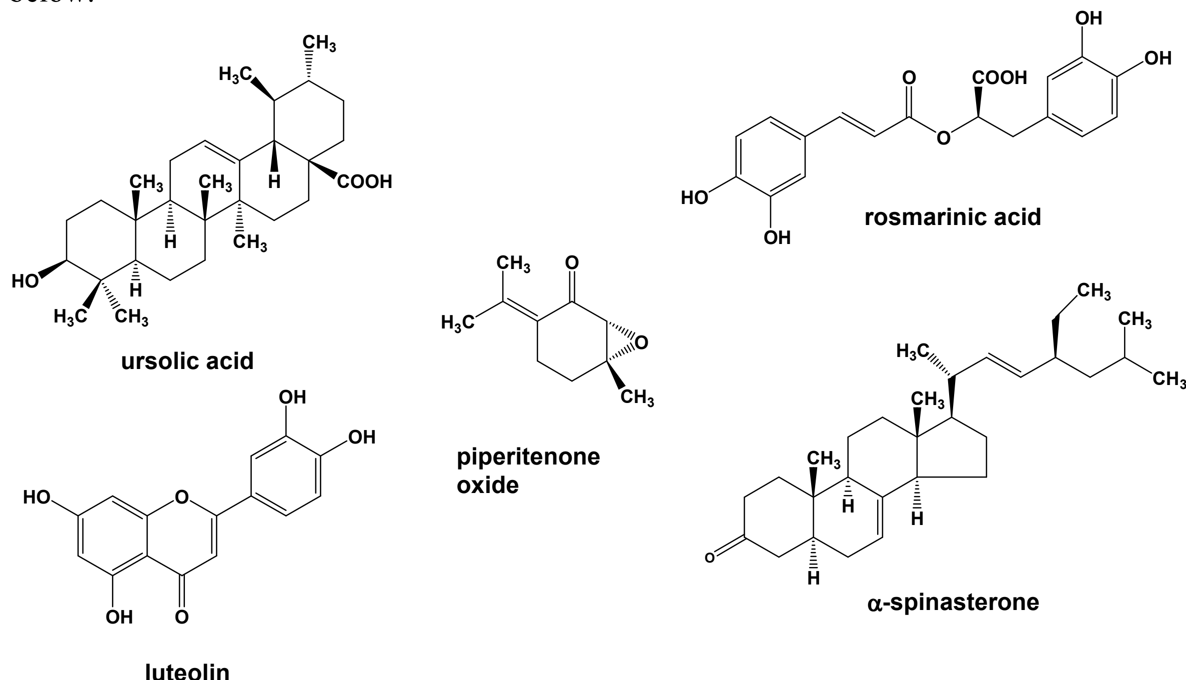
Clinopodium umbrosum (M. Bieb.) C. Koch (Gurung language: *Sarshang*) belongs to the family Labiatae. This plant has been reported from Iran, Afghanistan, Pakistan, the Himalayan region (Kashmir to Bhutan), India, Myanmar, Sri Lanka, China, Taiwan and Malaysia at the altitude range from 180 to 3400 meter.

Traditional use in Manang

Powdered stem, leaves and roots are introduced into burning coal. Persons with high blood pressure, body inflammation, pain and paralysis are allowed to smell the scent produced.

Chemical constituents

The isolated compounds from this plant include steroids like α-spinasterone, *β*-sitosterol, stigmasterol, *α*-spinasterol, and *α*-spinasteryl-3-*O*-*β*-glucopyranoside; triterpenoids like 3*β*-hydroxyurs-11-en-28,13-olide, betulinic acid, oleanolic acid, ursolic acid; flavonoids like luteolin, luteolin-7-*O*-*β*-glucopyranoside, apigenin-7-*O*-*β*-glucuronide and apigenin-7-*O*-*β*-methylglucuronate and lignolic acids like [3-(3,4-dihydroxyphenyl)-lactic acid and rosmarinic acid (100). Isosakuranetin, naringenin-7-rutinoside, xiangfongcaodai, and jiangfuyinghuasu were also isolated from *C. umbrosum* (101). The major components in the essential oil of *C. umbrosum* were *cis*-piperitone oxide (63.05%) and piperitenone oxide (17.98%) (102). The structures of representative isolated compounds are presented below.



Biological properties

Biological activity studies are lacking in this plant.

Cordyceps sinensis

Cordyceps sinensis (Berk.) Sacc (Gurung language: *Yartsagumba*) belongs to the family Clavicipitaceae. It is found in the Himalayan region (Kashmir to Bhutan) and Tibet at the elevation range of 3500 to 4500 meter.

Traditional use in Manang

Powdered yartsagumba is mixed with powdered root of *Dactylorhiza hatagirea* (panchaule) and is placed in honey or milk. This constitutes a potent tonic. One piece of yartsagumba is immersed on homemade alcoholic drink to make it tonic.



Cordyceps sinensis

Chemical constituents

Amino acids, cyclic dipeptides, saccharides & sugar derivatives, steroids, nucleotides & nucleosides, polyamines, saturated & unsaturated fatty acids and vitamins have been isolated from *C. sinensis.* Isolated amino acids are phenylalanine, proline, histidine, valine, oxyvaline and arginine. Cyclic dipeptides such as cyclo-(gly-pro), cyclo-(leu-pro), cyclo-(val-pro), cyclo-(ala-leu), cyclo-(ala-val) and cyclo-(thr-leu) have also been isolated. Mannitol and other oligosaccharides and polysaccharides have also been obtained. Isolated steroids include ergosterol, delta-3 ergosterol, ergosterol peroxide, sitosterol, daucosterol and campasterol. Similarly, adenine, uracil, guanine, thymidine, guanosine, uridine and deoxyuridine have been isolated. Several saturated and unsaturated fatty acids including oleic, linoleic, palmitic and stearic acids have also been isolated (103).

Biological properties

C. sinensis is a valuable crude drug. It has a wide veriety of biological properties. It helps improve physical performance; reproductive functions (higher sperm count, reduction of malformed spermatozoa, increased survival rate of spermatozoa); cardiovascular and circulatory functions (improvement in chest distress and palpitation, relaxation of artery, atherosclerosis inhibition, reduction of cholesterol, triglycerides and blood sugar etc); respiratory system (decreased cough frequency, improvement in chronic bronchitis and bronchial asthma); kidney and renal systems (reduction of blood urea and creatine, nephro-protective etc) and hepatic system. It also helps arrest the growth of cancer cells (103).

Cynanchum canescens

Cynanchum canescens (Willd.) K. Schum. (Gurung language: *Dhugmoyung*) belongs to the family Asclepiadaceae. It is found in Afghanistan, Pakistan, the Himalayan region (Kashmir to Bhutan), China (Sichuan, Xizang and Yunan), Russia and south west Asia at the altitude range of 2130 to 3660 meter.

Traditional use in Manang

Powdered flower and leaves are taken orally with boiled water for the conditions related to cold & cough, diarrhea, dysentery, kidney disease, fever and stomachache. Furthermore, fresh flower and seeds juices are administered on the ear in case of ear pain.

Chemical constituents and biological properties

Chemical and biological studies are lacking in this plant.

Cynoglossum zeylanicum

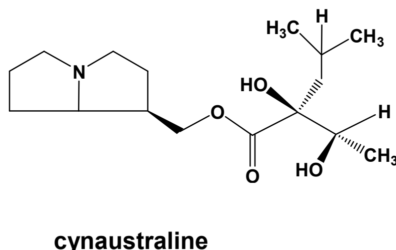
Cynoglossum zeylanicum (Vahl) Thunb. ex Lehm. (Gurung language: *Thina*) belongs to the family Boraginaceae. It is found in Afghanistan, the Himalayan region (Kashmir to Nepal), India, Sri Lanka, eastern China, Japan and Malaysia at the altitude range of 1200 to 4100 meter

Traditional use in Manang

A paste is made by pounding the flowers on a stone slab. This paste is applied around the boils. It draws the pus and subsequently, healing process takes place.

Chemical constituents

A pyrrolizidine alkaloid, cynaustraline, as well as β-sitosterol and lauric acid have been obtained from *C. zeylanicum* (104). The structure of cynaustraline is presented below.



cynaustraline

Biological properties

C. zeylanicum forms a part of several patented Chinese traditional medical formulations. The formulations include treatments for alopecia (105), anorectal diseases (106), hemorrhoids (107) and prostate diseases and sexual disorders (108).

Dactylorhiza hatagirea

Dactylorhiza hatagirea (D. Don) Soo (Gurung language: *Panchaule*; Amchi term: *Lovha*) belongs to the family Orchidaceae. It is found in west Pakistan, the Himalayan region (Kashmir to Bhutan) and south east Tibet at the elevation range of 2800 to 3900 meter.



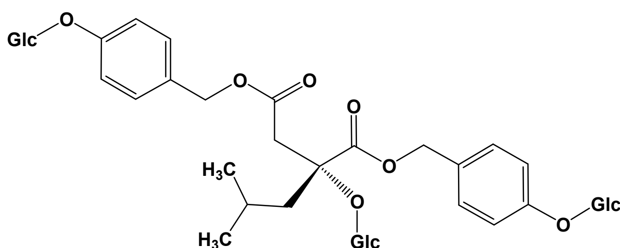
Dactylorhiza hatagirea

Traditional use in Manang

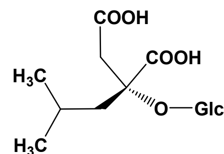
The paste obtained from its roots has beneficial effect on boils, cuts, wounds, burns, scabies, snakebite and scorpion stings. Furthemore, powdered plant is mixed with powdered *Cordyceps sinensis* (yartsagumba) and put into honey or milk. This preparation is considered a health tonic.

Chemical constituents

From the dried roots of *D. hatagirea*, major isolated compounds include dactylorhins A, B, C, D &E and dactyloses A and B along with 4–(β –D-glucopyranosyloxy)benzyl alcohol, militarine, loroglossin and (2*R*)–2-hydroxy-2–(2– methylpropyl) butanedioic acid (109). The structures of dactylorhins A and C are given below.



dactylorhin A



dactylorhin C

Biological properties

The plant extract has been found to be aphrodisiac (110). A cerebroside isolated from *D. hatagirea* is shown to be blue mussel *(Mylitus edulis*) repellant, ionphoretic and anti–ulcergonic (111).

Delphinium brunonianum

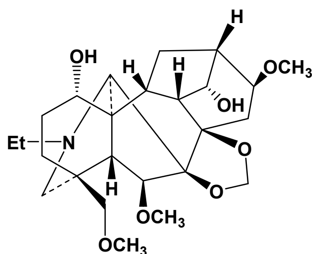
Delphinium brunonianum Royle (Gurung language: *Ponmar*) belongs to the family Ranunculaceae. It is distributed in Pamir, Afghanistan, the Himalayan region (Kashmir to Nepal) and south east Tibet at the altitude range of 3500 to 6000 meter.

Traditional use in Manang

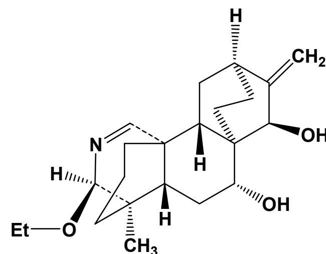
The whole plant is boiled with water. This decoction is useful for jaundice and fever.

Chemical constituents

Diterpenoid and nor-diperpenoid alkaloids have been isolated from *D. brunonianum*. A diterpene alkaloid, brunonine was obtained from this plant (112). From its aerial part, a nordiperpenoid alkaloid named as delbruninol along with other alkaloids delcosine, browniine, blacknidine, delbrunine, 18-methoxygadesine and nudicaulamine have been isolated. Its roots contained methyllycaconitine and lycoctonine. (113). Furthermore, three more C19–diterpenoid alkaloids, delbrunine, delbruline and delbrusine were obtained (114). The structures of two diterpenoidal alkaloids isolated from this plant are presented below.



delbruninol



brunonine

Biological properties

Methanol extract of *D. brunonianum* exhibited antiviral activity (EC_{50} = 25 μg/mL) against influenza virus A (15).

Delphinium stapeliosum

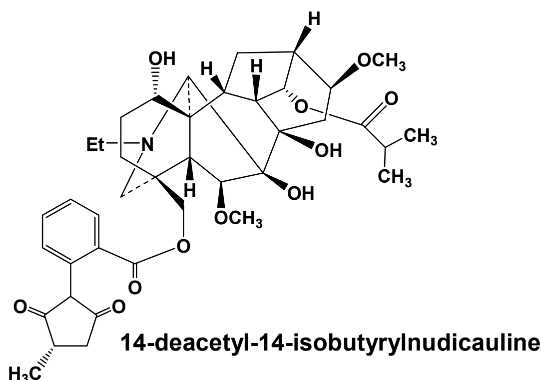
Delphinium stapeliosum Bruhl ex Huth (Gurung language: *Ponmar*) belongs to the family Ranunculaceae. It is distributed in Nepal, Khasi and north Myanmar at the altitude range of 1200 to 3000 meter.

Traditional use in Manang

Pounded whole plant is mixed with water and milk and is orally taken in case of the fever due to typhoid and malaria. In order to cotrol the weakness associated with this medication, tonic in the form of *Dactylorhiza hatagirea* (panchaule) and *Cordyceps sinensis* (yartsagumba) are taken as well. Sometimes, powdered whole plant is mixed with the yak (*chauri*) ghee and is taken.

Chemical constituents

From the roots of *D. stapeliosum*, norditerpenoid alkaloids have been isolated. They include 14-demethyltuguaconitine, 14-deacetyl-14-isobutyrylnudicauline, 14-deacetyl-14-isobutyrylajadine, delbonine, methyllycaconitine, 14-deacetylnudicauline, ajacine, deltatsine, delcosine, 14-deacetylajadine, nudicauline, and ajadine (115). The structure of 14-deacetyl-14-isobutyrylnudicauline is written below.



14-deacetyl-14-isobutyrylnudicauline

Biological properties

Biological activity studies are lacking in this plant.

Dicranostigma lactucoides

Dicranostigma lactucoides Hook. f. & Thompson (Gurung language: *Rhafendhi*) belongs to the family Papaveraceae. It is found in the Himalayan region (Garhwal to Nepal) at the altitude range of 2700 to 4000 meter.

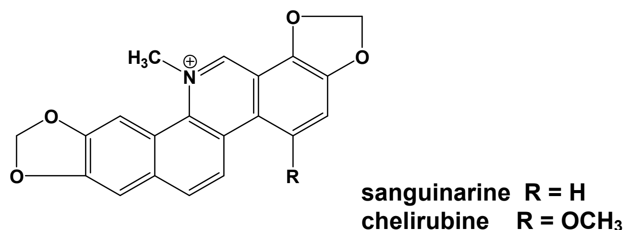
Traditional use in Manang

Its roots are pounded on a stone slab. The pounded root is cooked with wheat flour and rice. It is fed to the animals. It induces labour pain in animals thereby delivery is hastened.

Chemical constituents

Quaternary benzo[c]phenanthridine alkaloids are present in this plant. From the aerial part of *D. lactucoides*, (+)-isocorydine, protopine, α–allocryptopine, chelerythrine, sanguinarine, chelirubine, coptisine and berberine have been isolated. Its roots contained

chelerythrine as the major alkaloid along with protopine, α–allocryptopine, sanguinarine, oxysanguinarine, coptisine, berberine and corytuberine (116). The structures of two benzo[c]phenanthridine alkaloids isolated from *D. lactucoides* are presented below.



Biological properties

Quaternary benzo[c]phenanthridine alkaloids possess interesting biological properties. Sanguinarine and chelirubine are shown to be antimicrobial, antifungal, anti-inflammatory, adrenolytic, sympatholytic and local anaesthetic. They are used in dental care products (117). Sanguirubine and chelirubine exhibited potent antiproliferative activity (118). *D. lactucoides* aqueous extract retarded the growth of cyanobacteria, algae and other non-target aquatic organisms pointing to its potential use as algicides or cyanocides in the aquatic environment (119).

Elsholtzia eriostachya

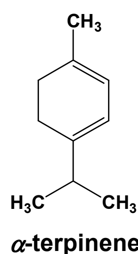
Elsholtzia eriostachya (Benth.) Benth. (Gurung language: *Thumpe*; Amchi term: *Chirukgherna*) belongs to the family Labiatae. It is found in the Himalayan region and China at the elevation range of 3500 to 4000 meter.

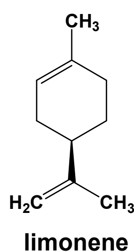
Traditional use in Manang

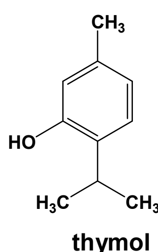
Powdered stems, leaves and flowers are taken with hot water for stomachache. A paste is made from smashing stem, leaves and flowers. The paste is applied to boils, wounds and other skin diseases. Powdered stems, leaves and flowers are also applied in case of toothache.

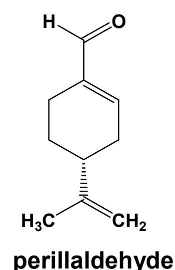
Chemical constituents

Flavonoids such as luteolin-5-*O*-β-D-glucoside, luteolin-7-*O*-β-D-glucoside, hyperoside, morin-7-*O*-β-D-glucoside, isoskranetin-7-*O*-β-D-neohesperidoside and acatetin-7-*O*- β-D-rutinoside have been obtained from *E. eriostachya* (120). Furthermore, dotriacontanoic acid, β-sitosterol, succinic acid, aretigenin, 3-hydroxyarctiin and gentisic acid 5-*O*-β-D-glucopyranoside were isolated from this plant (121). The essential oil obtained from *E. eriostachya* var. *pusilla* growing in the Kumaun region (India) contained thirty-six compounds of which major components were α-limonene, α-terpinene, thymol, and perillaldehyde (122). The structures of the components present in its essential oil are presented below.









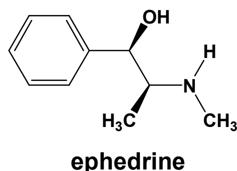
Biological properties
The plant forms a part of patented traditional Chinese medicinal formulation having analgesic, antihemorrhagic and anti-inflammatory effects (123).

Ephedra gerardiana

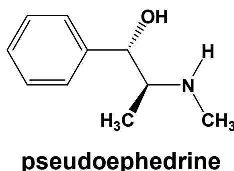
Ephedra gerardiana Wall. ex Stapf (Gurung language: *Somalatha*) belongs to the family Ephedraceae. This plant is distributed in Afghanistan, the Himalayan region (Kashmir to Sikkim), north India, China and Tajikstan at the elevation range of 3700 to 5300 meter.

Traditional use in Manang
The powdered root is taken with boiled water in conditions arising from respiratory diseases such as cold & cough, asthma, bronchitis and heavy breathing. It is diuretic as well as dysuric. It helps stop sweating. Alternatively, the powdered root is boiled with water. This decoction is useful for body pain, cold & cough, asthma and high altitude sickness. These preparations are usually mixed with other kinds of medicine such as *Cordyceps sinensis* (yartsagumba) and honey.

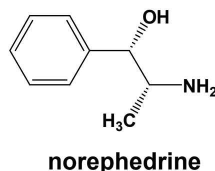
Chemical constituents
Ephedrine and pseudoephedrine are the main bioactive alkaloids of ephedra plants. Other minor alkaloids in the ephedra plant usually found are norephedrine, norpseudoephedrine, methylephedrine and methylpseudoephedrine (124). A study was done to assess the tannin and flavonoid contents of *E. gerardiana* and *E. pachyclada* and it was found that *E. gerardiana* contained lesser amount of tannin, flavonoids and alkaloids than *E. pachyclada* (125). The structures of major ephedra alkaloids are presented below.



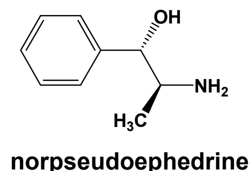
ephedrine



pseudoephedrine



norephedrine



norpseudoephedrine

Biological properties
Ephedrine works as a sympathomimetic agent and finds its application as stimulant, decongestant and appetite suppressant (126). Acetone extract of *E. gerardiana* inhibited pregnancy in rats (127).

Euphorbia longifolia

Euphorbia longifolia D. Don (Synonym: *Euphorbia mellifera* Ait.) (Gurung language: *Dhurbi*; Amchi term: *Si*) belongs to the family Euphorbiaceae. It is found in Nepal at the altitude range of 1700 to 2900 meter.



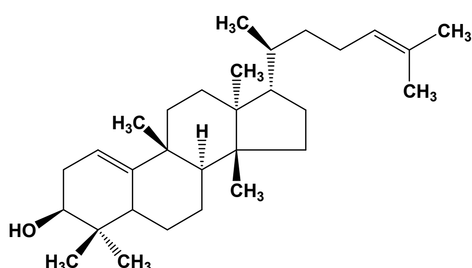
Euphorbia longifolia

Traditional use in Manang

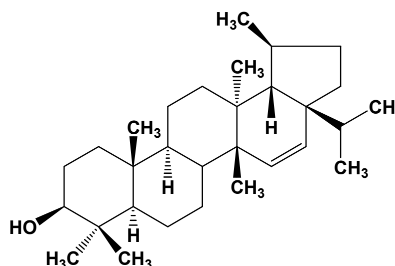
The powdered root is taken with boiled water for the relief of cold & cough, fever and sinusitis. The root decoction is used for skin diseases.

Chemical constituents

Various triterpines have been isolated from *E. mellifera*. The isolated triterpenes include taraxerone, moretenone, lanosterol, butyrospermol, cycloartenol, 24-methylene-cyloartenol (128), euferol, melliferol (129) and D:C-firedornadeir-14-en-3β-ol, D:C-firedornadeir-14-en-3–one, D:C-friedomadeir-7-en-3β-ol, D:C-friedomadeir-7-en-3-one (130). The structures of two isolated triterpenes are written below.



melliferol



D:C -firedornadeir-14-en-3β-ol

Biological properties

Methanol extract of *E. longifolia* had antiviral activity (EC_{50} = 19 μg/mL) against influenza A virus (15).

Fragaria nubicola

Fragaria nubicola Lindl. ex Lacaita (Synonym: *Fragaria vesca* var. *nubicola* Hook. f.) (Gurung language: *Shafaltang*; Amchi term: *Shagi*) belongs to the family Rosaceae. It is found in the Himalayan region (Kashmir to Bhutan), north Myanmar and west China at the elevation range of 1600 to 4000 meter.

Traditional use in Manang

Whole plant is pounded on the stone slab.The pounded plant is then boiled with water. This decoction is useful in case of complications arising from menstrual disorder, cold & cough, veins pain, edema and numbness of limbs.

Chemical constituents

In berry juice of *F. vesca*, acids such as citric and malic acids were found; however, tartaric, oxalic, benzoic and salicylic acids were missing. The juice also contained reducing sugars and cane sugars (131). *F. vesca* leaves contained an ellagitannin. This ellagitannin broke down to produce ellagic acid, gallic acid and glucose together with the flavonols like quercetin and quercitrin (132). Anthocyanins such as pelargonidin-3-glucoside and cyanidin-3glucoside have been detected in the berries of *F. vesca* (133). Water soluble procyanidins obtained by fermentation of a tannin extract of roots of *F. vesca* were found to consist of three dimers, procyanidins B1, B2 and B5 and two monomers, (+)-catechin and (-)-epicatechin (134). Chromatographic studies of *F. vesca* leaves revealed the presence of 26 phenolic compounds belonging to flavonoids, coumarins and phenol carboxylic acids classes. Pectin and hemicelluloses were also obtained from the leaves (135).

Biological properties

The berries of *F. vesca* L. were mildly diuretic (136). *F. vesca* has been described to possess antimicrobial property (137). The water-soluble procyanidins obtained from fermentation of the tannin extract of *F. vesca* had antiulcer property (138). Furthermore, water-soluble procyanidins obtained by fermentation of tannin extract of roots of *F. vesca* demonstrated antibacterial and angioprotective properties (134). The antioxidant activity of *F. vesca* has been attributed to the flavonoids, coumarins and phenol-carboxylic acid derivatives present in the plant (139).

Gentiana robusta

Gentiana robusta King ex Hook. f. (Gurung language: *Kiyce*; Amchi term: *Kicchakarba*) belongs to the family Gentianaceae. It is found in the Himalayan range (Nepal to Sikkim) at the altitude of around 3500 meter.

Traditional use in Manang

Leaves and flowers are boiled with water. The decoction is taken for the relief of stomachache, fever and edema. Its flower paste is used for cuts, wounds, boils and swelling of the body.

Chemical constituents and biological properties

Chemical and biological studies are lacking in this plant.

Geranium donianum

Geranium donianum Sweet (Gurung language: *Kagheshurti*) belongs to the family Geraniaceae. It is found in the Himalayan region (Nepal to Bhutan) and south Tibet at the elevation range of 3200 to 4800 meter.

Traditional use in Manang

Flowers and leaves are rubbed on the palm by fingers. This paste is kept on a smoking pipe (*hukka*). This smoking is useful for gingivitis and toothache.

Chemical constituents and biological properties
Chemical and biological studies are lacking in this plant.

Galium boreale

Galium boreale L. (Gurung language: *Mara*) belongs to the family Rubiaceae. The plant is found in tropical and temperate regions of Asia, Europe and north America.



Galium boreale

Traditional use in Manang
The whole plant paste is administered around the boils. This treatment supposedly removes the pus and healing process starts.

Chemical constituents
Three flavonoid glycosides have been detected on the chloroform extract of the plant of which quercetin galactoside was identified (140).

Biological properties
G. boreale forms a part of patented plant tea for treatment of chronic pyelonephritis, cystitis, and uroclepsia (141).

Gynura nepalensis

Gynura nepalensis DC. (Gurung language: *Mendho*) belongs to the family Compositae. It is found in the Himalayan region (Kashmir to Bhutan), Assam, Myanmar, Thailand and China at the altitude range of 250 to 2000 meter.

Traditional use in Manang
The fresh latex is used to clot the bleeding.

Chemical constituents and biological properties
Chemical and biological studies are lacking in this plant.

Heracleum candicans

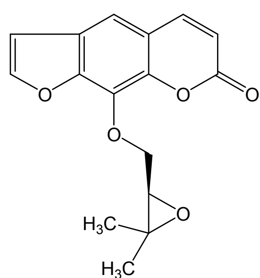
Heracleum candicans Wall. ex DC. (Gurung language: *Tokar*) belongs to the family Umbelliferrae. It is found in the Himalayan region (Kashmir to Bhutan), Tibet and Yunan at the altitude range of 2200 to 3800 meter.

Traditional use in Manang

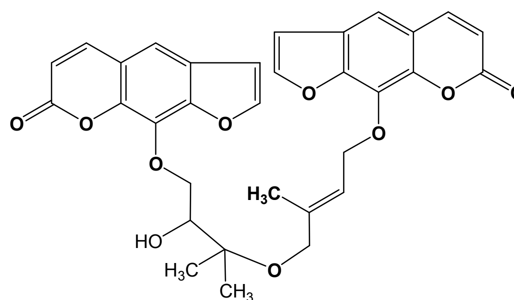
Either the root decoction or powdered root with water is taken in the conditions related to blood pressure, bone diseases, stomachache, diarrhea, dysentery and joint pains. The root paste is useful for boils, wounds, skin diseases and blisters.

Chemical constituents

H. candicans is rich in furocoumarins. Its root is shown to contain imperatorin, heraclenin, heraclenol, 8-geranyloxypsoralen, xanthotoxin, imperatorin, sphondin, xanthotoxol, psoralen, bergapten, isopsoralen, tert-*O*-methylheraclenol, isoheraclenin, and tert-*O*-imperatorinylheraclenol (142). The root is also found to contain 8-geranyloxy-psoralen, angelicin, stearic acid, and β-sitosterol (143). Candicanin, a bicoumarinyl derivative (144), candibirin A, a furanocoumarin dimmer (145) and candicopimaric acid (146) have also been reported from its root. Furthermore, from its root, alkyl coumarins, isophellodenol C, candinol A; spirobifuranocoumarins, candibirins B-E and trifuranocoumarins, canditririns A–B have been obtained (147). The essential oil obtained from its seed contained α-pinene, *p*-cymene, limonene, curcumene, β-bisabolene, cadinene, β-selinene , β-elemene, butyl butyrate, iso-butyl 2-methylbutyrate, n-butyl isovalerate, n-hexyl isobutyrate, butyl hexanoate, octyl acetate , hexyl pentanoate, amyl acetate, bornyl acetate, hexyl caproate, neryl acetate, linalool, santenol, capric acid, lauric acid, myristic acid, palmitic acid and santalic acid (148). The root essential oil had turpentine smelling property and consisted of α-pinene, β-pinene, carveyl acetate, phenylpropionaldehyde, phenylethyl alcohol, phenylpropyl acetate and dihydrocarveol (149). The structures of heraclenin and candicanin are presented below.



heraclenin



candicanin

Biological properties

Bioactivity-guided fractionation of *H. candicans* followed by subsequent separation yielded heraclenin as the anti-inflammatory principle (150). Furocoumarins of *H. candicans*, particularly xanthotoxin finds application in the treatment of leucoderma (151). Furocoumarins such as psoralen, xanthotoxin, bergapten and isopimpinellin and sphondin displayed potent melanogenesis stimulation activity (152).

Hippophae salicifolia

Hippophae salicifolia D. Don (Gurung language: *Tarbu*) belongs to the family Elaeagnaceae. It is found in the Himalayan region (Punjab to Bhutan) and south Tibet at the altitude range of 2200 to 3500 meter.



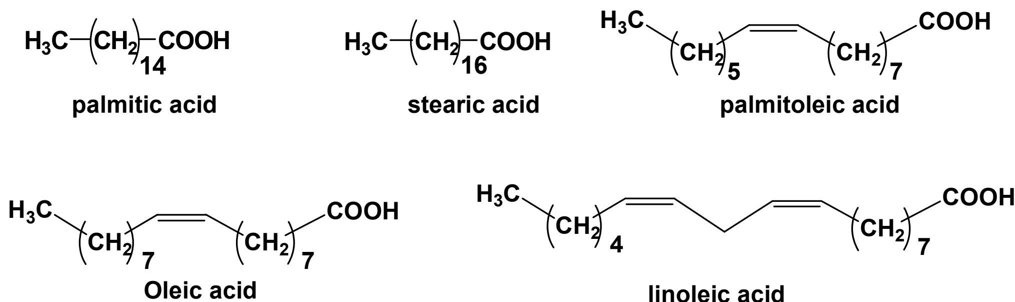
Hippophae salicifolia

Traditional use in Manang

Its juice is mixed with water and is taken for the relief of cold & cough, chest pain, stomachache, diarrhea, dysentery, rheumatism and gastritis. Fruits are boiled with water and is taken for the above mentioned diseases as well.

Chemical constituents

H. salicifolia berries contain 4.6 % oil. The oil has the following characterstics: acid value (mg KOH/g) 4.7, saponification value (mg KOH/g) 184.3, peroxide value (meq/kg) 18.3, unsaponifiable matter (%) 0.78 and iodine value (g I_2/100 g) 155.0. The fatty acid content of the oil were oleic (31.9%), linoleic (27.9%), linolenic (17.8%) and palmitic (16.3%) acids where as palmitoleic and stearic acids were found in small amounts (≤ 6.6%). Vitamin E in the oil was found in the range of 27.6-30.8 μg/g (153). In one another study, palmitoleic acid was described as the most abundantly available fatty acid in *H. salicifolia* berries. Its berries are also shown to contain higher amounts of lipophobic constituents such as vitamin C and flavonols (154). In its bark, long chain fatty acids, sterol glucoside, *β*-sitosterol and alkaloids have been detected (155) (156). The structures of isolated fatty acids are presented below.



Biological properties

The common name of *Hippophae* species is seabuckthron. Seabuckthron oil is a well known traditional medicine. The oil has traditionally been described as potent antioxidant and is endowed with properties beneficial in cancer cure, cardiovascular risk reduction, skin diseases and gastrointestinal ulcer and liver protections (157). *H. salicifolia* oil showed antibacterial property. The oil has been described as having potential for use in cosmetics, health products and nutraceuticals (153). Effect of *H. salicifolia* on reproductive organs of male rats has been studied (158). The plant forms a part of patented herbal formulations for the prevention and management of senile dementia (159) as well as for prevention and management of coryza (common cold) (160).

Hippophae tibetana

Hippophae tibetana Schlecht. (Gurung language: *Tarbu*) belongs to the family Elaeagnaceae. It is found in the Himalayan region (Punjab to Bhutan), south Tibet and north west China at the altitude range of 3800 to 4500 meter.

Traditional use in Manang
Its juice is mixed with water and this preparation is considered tonic, diuretic and stimulant. It is also used for cold and cough. Fruits are boiled with water and are taken as well.

Chemical constituents
H. tibetana oil contained palmitoleic acid as the most abundant fatty acid followed by palmitic, oleic, linoleic, and linolenic acids. α-Tocopherol was present in substantial amount. The oil was found to contain higher amount of lipophilic carotenoids and tocopherols (154).

Biological properties
The common name of *Hippophae* species is Seabuckthron. Seabuckthron oil has several traditional medical uses. The oil aside from being antioxidant finds beneficial applications in cancer cure, cardiovascular risk reduction, skin diseases, gastrointestinal ulcer and liver protections (157).

Hyoscyamus niger

Hyoscyamus niger L. (Gurung language: *Lantang*) belongs to the family Solanaceae. It is found in Afghanistan, China, India, Japan, Kazakhstan, Korea, Kyrgyzstan, Nepal, Pakistan, Russia, Tajikistan, Turkmenistan, Uzbekistan, South West Asia, north Africa and Europe at the elevation range of 700 to 3600 meter.

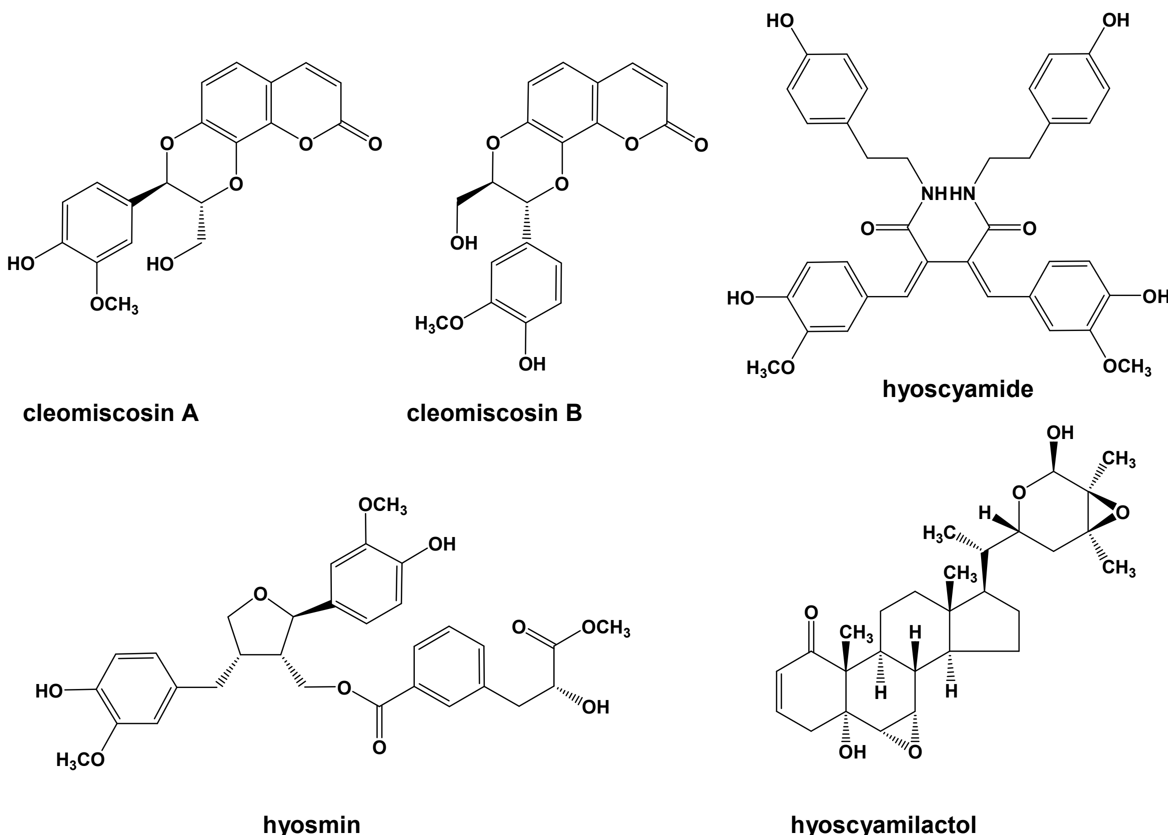


Hyoscyamus niger

Traditional use in Manang
Powdered flower is placed on coal fire. Thus produced smoke is introduced to the infected teeth for gingivitis and toothache. Powdered flower is applied to infected teeth as well. Some times dried seeds are mixed with tobacco and smoked.

Chemical constituents
H. niger is a source of the bioactive tropane alkaloids, hyoscyamine and scopolamine. Recemic mixture of RS- hyoscyamine is called atropine. A lignan, hyosmin, has been isolated from *H. niger* (161). Coumarinolignans such as hyosgerin venkatasin, cleomiscosin A and cleomiscosin B were obtained from the seeds of *H. niger* (162). Other nonalkaloid components from its seeds are hyoscyamide, 1,24-tetracosanediol diferulate, 1-*O*-(9*Z*,12*Z*-octadecadienoyl)-3-*O*-nonadecanoyl glycerol, 1-*O*-(9*Z*,12*Z*-octadecadienoyl)-3-*O*-nonadecanoyl glycerol, grossamide, cannabisin D, cannabisin G, *N*-*trans*-feruloyl

tyramine, 1-O-octadecanoyl glycerol, 1-*O*-(9*Z*,12*Z*-octadecadienoylglycerol, 1-*O*-(9*Z*,12*Z*-octadecadienoyl)-2-*O*-(9*Z*, 12*Z*-octadecadienoyl) glycerol, 1-*O*- (9*Z*,12*Z*-octadecadienoyl)-3-*O*-(9*Z*-octadecenoyl)glycerol, rutin, vanillic acid, β-sitosterol, and daucosterol (163). Furthermore, three withanolide type steroids named hyoscyamilactol, daturalactone-4 and 16α-acetoxyhyoscyamilactol were isolated (164). The structures of representative isolated compounds are given below.



Biological properties
Atropine is a well known drug. It is used to dilate the pupil of the eyes. It functions as anticholinergic (27) and finds application in the treatment of condition of extreme low heart rate. It also acts as muscle relaxant and antispasmodic agent. Scopolamine too is an anticholinergic medicine. It finds applications in the treatment of nausea and motion sickness, intestinal cramping, dilation of the pupils of the eyes and sedation before anesthetic procedure. Nonalkaloids such as grossamide and cannabisins D and G exhibited moderate cytotoxicity in cultured LNCaP human prostate cancer cells (163).

Juglans regia

Juglans regia L. (Gurung language: *Katutun*) belongs to the family Juglandaceae. It is found in China, south east Asia, the Himalayan region and south east Europe at the elevation range of 500 to 4000 meter.



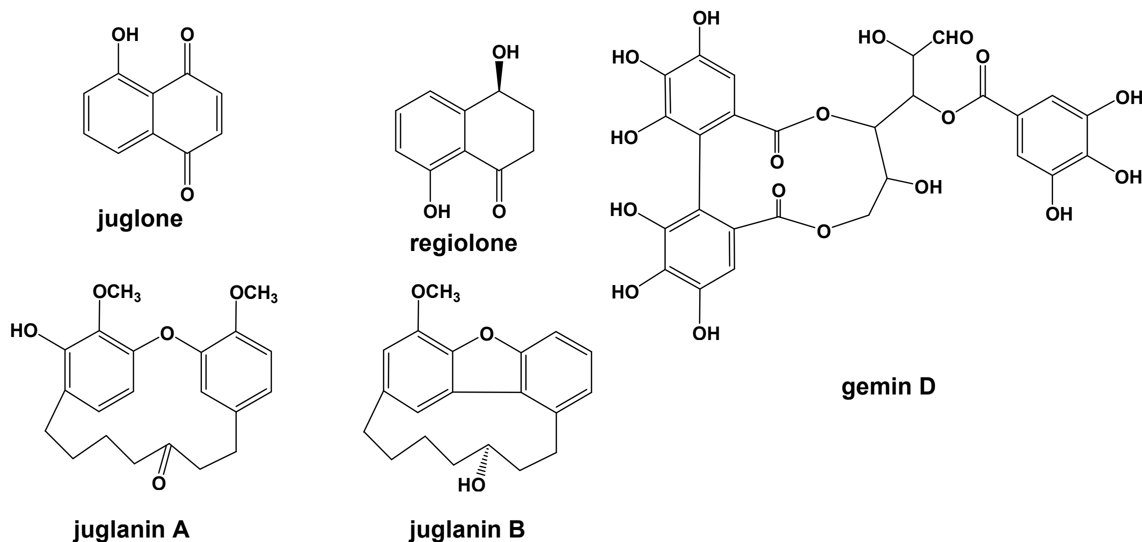
Juglans regia fruits

Traditional use in Manang

Powdered fruit is mixed with other herbs (unknown). This mixture is taken with hot water for stomachache.

Chemical constituents

From the bark of *J. regia* L. var. *orientalis*, glucose, mesoinositol, quercetin, quercitrin, and l-sakuranetin were obtained (165). From its stem bark, juglone, betulinic acid, regiolone and β-sitosterol have been isolated (166). Its seeds have afforded ellagitannins, glansrins A–C, together with other hydrolysable tannins (167). The hydrolysable tannins of 70% acetone extract of the seeds were identified as gemin D, casuariin, pedunculagin, tellimagrandin I, rugosin F and heterophylliin D (168). The major fatty acids found in *J. regia* were identified as linoleic (18:2n-6), α-linolenic (18:3n-3), oleic (18:1n-9), palmitic (16:0) and stearic acid (18:0). γ-Tocopherol was the main tocopherol homolog present followed by δ- and α-tocopherols. Tocopherols, particularly the γ-tocopherol, contributed mostly to antioxidant activities of *J. regia* (169). Cyclic diarylheptanoids juglanin A and juglanin B were also obtained from the percarp of *J. regia* (170). The structures of representative isolated compounds are below.



Biological properties

The trunk bark extract of *J. regia* showed high antioxidant, radical scavenging and anti-microbial properities (171). Its leaves too had strong antioxidant activity (172). Aqueous, water-alcohol and alcoholic extracts of the nuts of *J. regia* brought about the contraction of the small intestines of guinea pigs and rats. This contraction was inhibited by atropine and papaverine (173). *J. regia* is also shown to possess hepatoprotective activity (174). Juglone, one of the components of *J. regia*, is a naphthaquinone and naphthoquinones have significant pharmacological properties such as cytotoxic, antibacterial, antifungal, antiviral, insecticidal, anti-inflammatory and antipyretic (175).

Juniperus communis

Juniperus communis L. (Gurung language: *Phar*) belongs to the family Cupressaceae. It is distributed in northern temperate zone, north Africa, Europe, north America and the Himalayan region.



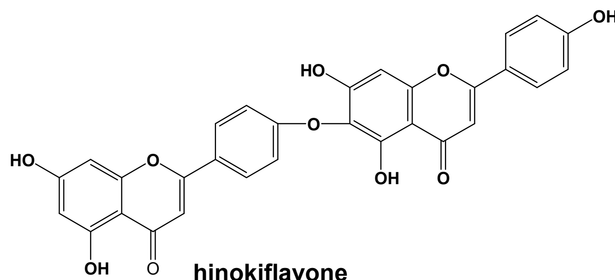
Juniperus communis

Traditional use in Manang

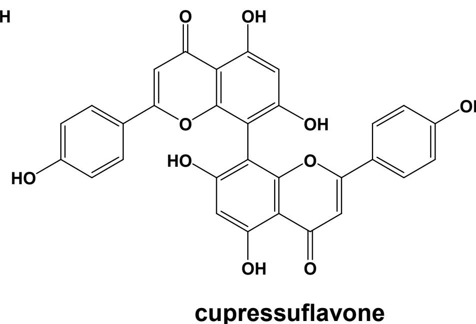
Fruits are taken for the conditions related to respiratory complaints, chest pain, lung infection and bronchitis. At times, powdered fruits are taken with hot water for these symptoms.

Chemical constituents

The essential oil from dry leaves (needles) of *J. communis* had twenty-seven constituents of which sabinene (22.8%) β-pinene (10.7%), *trans*-sabinene hydrate (6.0%) and γ-cadinene (10.6%) were the major components (176). Two other studies also showed that sabinene is the major constituent of *J. communis* leaves essential oil (177), (178). Flavonoids, biflavonoids, neolignan glucosides, phenylpropanoid glycosides, diterpenes have been obtained from *J. communis*. Flavonoids such as isoscutellarein and 8-hydroxyluteolin as well as biflavonoids such as amentoflavone, hynokiflavone, cupressuflavone and methyl-biflavones were found to be present in the berries of *J. communis* (179). Its fruits further afforded flavonoids such as apigenin, luteolin, luteolin-7-*O*-β-D-glucoside, quercitrin, robustaflavone, kaempferol-3-*O*-β-D-glucoside, kaempferol-3-*O*-α-L-rhamnoside and podocarpusflavone A (180). Labdane type diterpenes have also been obtained from its berries (181). Other diterpene acids in its leaves (182) and a sesquiterpene, β-elemen-7α-ol, (183) in its berries have been identified. The structures of two isolated biflavonoids are presented below.



hinokiflavone



cupressuflavone

Biological properties

J. communis essential oil is both antibacterial (184) and antifungal (185). The essential oil has antioxidant property as well (186). *J. communis* berries are shown to contain hypoglycemic activity (187). Aqueous ethanol extract of its bark exhibited strong lipase inhibitory activity (EC_{50} = 20.4 μg/mL) (188). The plant has abortifacient effect on the cattles (189). *J. communis* displayed inhibitory activity on prostaglandin biosynthesis and platelet-activating factor (PAF) induced exocytosis *in vitro* showing its anti-inflamamatory properties (190).

Juniperus indica

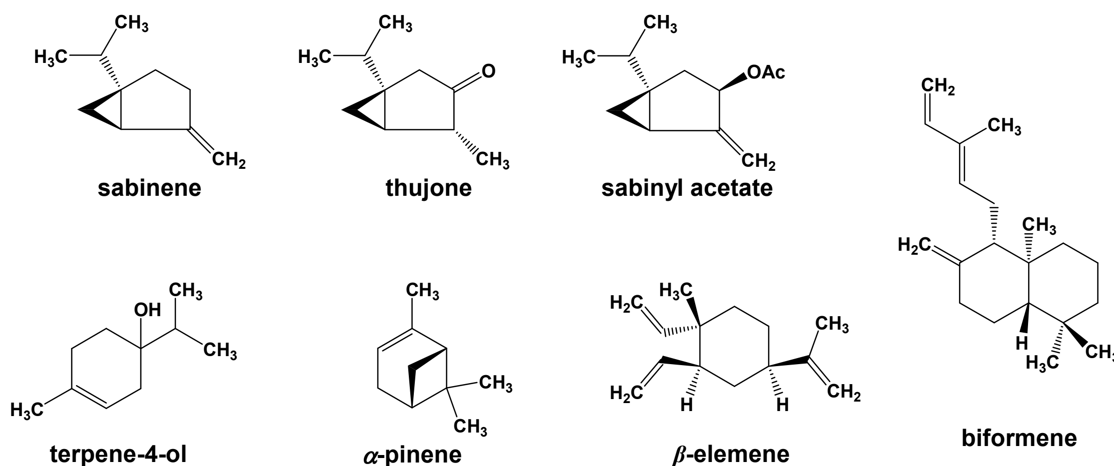
Juniperus indica Bertol. (Gurung language: *For*) belongs to the family Cupressaceae. It is distributed in Karakorum, the Himalayan region (Kashmir to Nepal), south east Tibet and west China at the elevation range of 3700 to 4100 meter.

Traditional use in Manang

Powdered leaves and fruits are mixed with milk and are taken for the treatment of cold & cough, tonsillitis, chest pain, headache, malarial fever, neck pain and blood pressure. In the *Amchi*'s treatment, powdered leaves and fruits are placed on burning coals. The patients are allowed to smell the scent.

Chemical constituents

From the leaves of *J. indica*, six biflavones were isolated of which four were identified as amentoflavone, cupressuflavone, hinokiflavone and isocryptomerin (191). Its leaves essential oil had twenty-seven components of which sabinene (34.9%) was the major constituent followed by terpinen-4-ol (10.8%) and α-pinene (8.9%) where as in the twig essential oil, biformene (12.0%) was the major constituent followed by terpinen-4-ol (11.1 %) and β-elemene (10.2%) (192). The leaf essential oil of *J. indica* collected from Nepal was found to possess sabinene (19.4-31.3%), β-thujone (4.5-25.8%), terpinen-4-ol (3.7-13.0%) and *trans*-sabinyl acetate (7.6-24.3%) (193). The structures of the components of its essential oil are given below.



Biological properties

The plant possesses anticancer properties (194).

Juniperus squamata

Juniperus squamata Buch.-Ham. ex D. Don (Gurung language: *Sukri*) belongs to the Family Cupressaceae. It is distributed in Afghanistan, the Himalayan region, north Myanmar and west China at the altitude range of 3300 to 4400 meter.

Traditional use in Manang

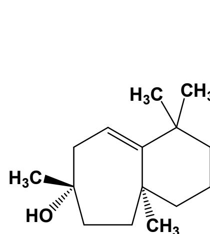
When domestic animals suffer from insect bite, scabies and wounds, small pieces of leaves and stems are placed on the floor of animal shed.



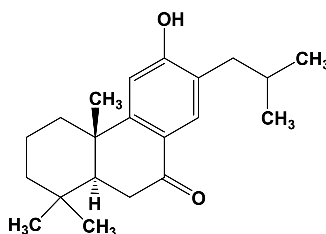
Juniperus squamata

Chemical constituents

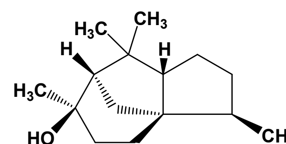
The plant is rich in sesquiterpenes. From the wood of *J. squamata* Lamb., sesquiterpenes such as 4-ketocedrol, isocedrolic acid and β-chamigrenic acid have been isolated. The other isolated compounds were 8,14-cedranoxide, cedrol, β-sitosterol, widdrol, procerin, 8,14-cedranediol, hinokiol, hinokiic acid and cedrolic acid (195). Other sesquiterpenes such as 4-oxocedrol (196) and isocedrolic acid (197) were also obtained from the plant. Two more sesquiterpenes, 3β-hydroxycedrol and widdringtonia acid II, were identified in the plant (198). Furthermore, the acetone extract of heartwood of *J. squamata* was shown to contain 8,14-cedranolide, 7-oxototarol, epicedranediol, widdringtonia acid and sugiol (199). *J. squamata* var. *fargesii* leaf essential oil had α-pinene (17.7-20.9%), sabinene (7.9-13.7%) and β-thujone as major components (200). The structures of three isolated terpenes are presented below.



widdrol



sugiol



cedrol

Biological properties

J. squamata contains anti-tumour activities (194). A compound isolated from *J. squamata*, 14-acetoxycedrol, had antiplatelet and vasorelaxing actions (201).

Maharanga bicolor

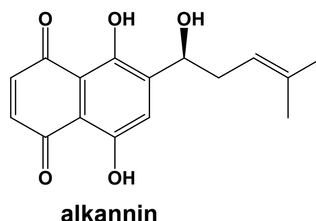
Maharanga bicolor (Wall. ex G. Don) A. DC. (Nepali language: *Maharangi*) belongs to the family Boraginaceae. It is distributed in the Himalayan region (Nepal to Bhutan) and west China at the elevation range of 2100 to 3000 meter.



Maharanga bicolor

Traditional use in Manang
It is used for ear pain. The root is squeezed to get juice. The juice is mixed with boiled mustard oil and is introduced inside the ear.

Chemical constituents
Naphthazarins were obtained from *M. bicolor*. These include alkannin, deoxyalkannin, acetylalkannin, alkannin β-hydroxyisovalerate and alkanninβ-acetoxy-isovalerate (202). The structure of alkannin is written below.



alkannin

Biolgical properties
Alkannin, acetylalkannin, alkannin β-hydroxyisovalerate and alkannin β-acetoxyisovalerate exhibited antibacterial activity against multiresistant human pathogenic *Staphylococcus* and *Enterococcus* species. Deoxyalkannin, alkannin β-hydroxyisovalerate and alkannin β-acetoxyisovalerate were found to possess antiviral activity against herpes simplex virus type-1 (202).

Maharanga emodi

Maharanga emodi (Wall.) A. DC. (Nepali language: *Maharangi*) belongs to the family Boraginaceae. It is distributed in the Himalayan region (Garhwal to Bhutan) and south Tibet at the altitude range of 2700 to 4500 meter.

Traditional use in Manang
The juice from root is mixed with mustard oil and is introduced inside the ear to cure ear pain.

Chemical constituents
Chemical studies are lacking in this plant.

Biological properties
M. emodi methanol extract displayed moderate anti-herpes viral activity (IC_{50} = 29 μg/mL) (15).

Malva verticillata

Malva verticillata L. (Gurung language: *Tangshang*) belongs to the family Malvaceae. It is distributed in Europe, Egypt, the Himalayan region (Kashmir to Bhutan), India, China and north east Asia at the elevation range of 2100 to 3000 meter.



Malva verticillata

Traditional use in Manang

Powdered flower of *M. verticillata* together with powdered flower of *Anisodus luridus* are taken with milk to cure cold & cough, tonsillitis and headache.

Chemical constituents

Several polysacchrides have been isolated from its seeds. From the seeds of *M. verticillata*, an acidic polysaccharide, MVS-VI, was obtained. It has a backbone chain composed of β-1,3-linked D-galactose residues and majority of galactose units in the backbone carry side chains composed of β-1,3- and β-1,6-linked D-galactosyl residues at position 6 (203). Another isolated polysaccharide is MVS-1 which is a neutral polysaccharide obtained from its seeds. It has a backbone chain composed of β-1,3-linked D-glucose and D-galactose residues having branches composed of α-1,5-linked L-arabinosyl β-1,4-linked D-galactose and of β-1,4-linked D-galactosyl β-1,3-linked D-glucose residues at position 6 of a part of D-galactose units as side chains (204). Among other isolated polysaccharides include MVS- II A and MVS-IIG (205) and MVS-IVA (206).

Biological properties

MVS-I (204), MVS-IVA (206) and MVS-VI (203) showed remarkable reticuloendothelial system-potentiating activity in a carbon clearance test and they are shown to possess anticomplementary activities. The plant forms a part of several patented herbal formulations. These include composition for treating urinary tract infection (207), beverage capable of preventing prostatitis (208) and several others.



Mentha longifolia

Mentha longifolia

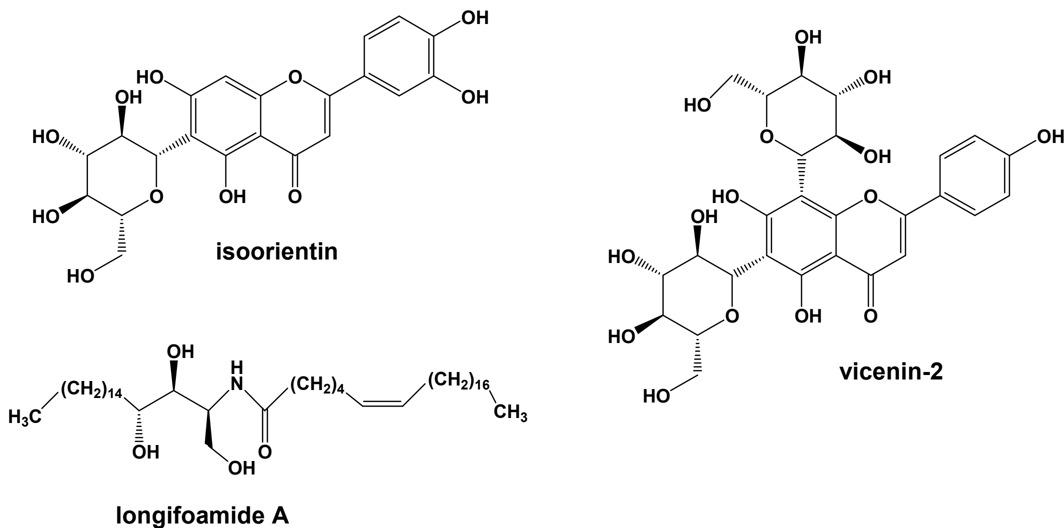
Mentha longifolia (L.) Huds. (Nepali language: *Patina*) belongs to the family Labiatae. It is distributed in Europe, Africa, Asia and north America at the elevation range of 1600 to 2700 meter.

Traditional use in Manang

Leaves are boiled in water. This decoction is taken for the remedy of cold & cough, tonsillitis and headache. Pickles made from its leave are said to increase and purify the blood.

Chemical constituents

Generally speaking, there exist two major chemo types of this plant: *M. longifolia* carvone chemo type and *M. longifolia* piperitone chemotype. The essential oil of wild *M. longifolia* (Linn.) Huds. (syn. *M. sylvestris* Linn.) collected from the Kumaon Himalaya had carvone as a major constituent (61.1-78.7%) followed by dihydrocarveol (0.40 - 9.45%), *cis*-carvyl acetate (0.16-6.43%) germacrene D (1.25-5.73%) *β*-caryophyllene (0.83-2.18%) and (*E*)-*β*-farnesene (0.45-1.54%) (209). Carvone (67.3%) was the principal consituent of the essential oil obtained from *M. longifolia* (L.) Huds. ssp. *schimperi* Briq. grown in Sudan. The other constituents were limonene (13.5%), 1,8-cineole (5.4%), menthone (2.9%), linalool (2.8%) and isomenthone (1.2%) (210). The essential oil from wildly grown *M. longifolia* Linn of Jammu region (India) is also found to contain carvone (57-61%) as the major component with limonene (1.67-2.69%), cineole-1-8 (0.62-2.00%) and *β*-caryophyllene (2.89-4.21%) as minor constituents (211). On the other hand, the volatile constituents of *M. longifolia* (L.) Huds. var. *asiatica* (Boriss.) Rech. f. from Iran were piperitone (67.6%), isomenthone (6.6%) and *cis*-piperitol (4.2%). Its flower essential oil contained piperitone (55.7%), carvone (16.2%) and pulegone (4.1%) (212). Similarly, the essential oils obtained from *M. longifolia* growing wild in Morrocco (213), Jordan (214) and Lithuania (215) had piperitenone oxide as the major constituent. Flavonoids such as luteolin-7-glucoside, luteolin-7-rutinoside, luteolin-7-glucuronide, apigenin-7-glucuronide, acacetin-7-rutinoside, diosmetin-7-rutinoside, hesperetin-7-rutinoside, eriodictyol-7-rutinoside have been obtained from *M. longifolia* (216). Further isolated flavonoids included isoorientin, vicenin-2, hypolaetin, lucenin-1, 7-*O*-neohesperidoside, tricetin-7-*O*-methylether 3'-*O*-glucoside 5'-*O*-rhamnoside, tricetin-3'-*O*-glucoside 5'-*O*-rhamnoside and tricetin-3'-*O*-rhamnosyl-(1→4)-rhamnoside (217) and 5,8,4'-trihydroxy-6,7,3'-trimethoxyflavone, myricetin-4'-methylether-3-*O*-rhamnoside, 5-hydroxy-6,7,3',4'-tetramethoxyflavone and 5-hydroxy-7,8,2',3'-tetramethoxyflavone (218). Furthermore, a chloro derivative of menthone, longifone I, an acylated *β*-sitosterol glycoside and a flavanone-glycoside, longitin III have also been obtained from *M. longifolia* (219). Cerebrosides such as longifoside-A and longifoside-B (220) as well as ceramides such as longifoamide-A and longifoamide-B (221) have also been reported from *M. longifolia*. The structures of isoorientin, vincenin-2, longifoamide-A are presented below.



Biological properties

M. longifolia essential oil is antibacterial, antifungal and antioxidant (222). *M. longifolia* crude ethanol extract, rich in luteolin glycosides , apigenin glycosides and phenolic acids brought about increase in hepatic glutathione and superoxide dismutase activity as well as a decrease of cytochrome P450 in CCl_4-induced liver injured mice demonstrating its hepatoprotective potential (223). Its polar extract had anti-insect property (224). *M. longifolia* essential oil exhibited a strong CNS depressant effect (225). Polar extracts of a new chemotype of *M. longifolia* are found to inhibit human immunodeficiency virus type 1 (HIV-1) (226). Its aqueous and ethanol extracts possessed anthelmintic activity (227).

Mirabilis himalaica

Mirabilis himalaica (Edgew.) Heimerl (Gurung language: *Nigghibulung*) belongs to the family Nyctaginaceae. It is found in western Himalayas to south east Tibet at the altitude range of 2300 to 4000 meter.

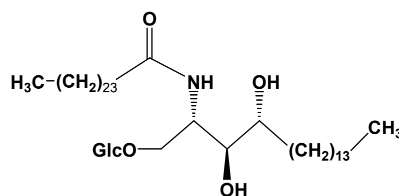
Traditional use in Manang

Leaves and flowers pastes are applied around fractured portion of the body.

Chemical constituents

Glycolipids such as *N*-pentacosanosyl-*β*-D-glucopyranosyl-(1-1')-phytosphingosine and its homolog, *N*-hexacosanosyl-*β*-D-glucopyranosyl-(1-1')-phytosphingosine along with daucosterol, syringaresinol-4'-*O*-*β*-D-monoglucoside, 2,3-dihydroxypropyl (*Z*,*Z*)-9,12-octadecadienate, ursolic acid, oleanolic acid and *β*-sitosterol were isolated from roots of *M. himalaica* (228) An amide, mirabliamide, together with boeravinone E were also obtained from *M. himalaica* (229). The structure of *N*-pentacosanosyl-*β*-D-glucopyranosyl-(1-1')-phytosphingosine is presented below.

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***N*-pentacosanosyl-*β*-D-glucopyranosyl-(1-1')-phytosphingosine**

Biological properties

M. himalaica forms a part of several patented herbal formulations. These include formulations for menstrual disorder (230), diabetes (231), gynecological diseases (232), kidney warming and yang invigorating (233), liver and bladder diseases (234) and prostatic diseases (235).

Morchella conica

Morchella conica Pers. (Gurung language: *Guchhichyaue*) belongs to the family Morchellaceae. It grows in temperate zone forests with distinct cold season especially with winter snow.



Morchella conica

Traditional use in Manang

Whole part is cooked as a vegetable. It is a general tonic as well as useful for stomachache and wound healing. Alternatively, a soup is made from dried mushroom.

Chemical constituents

Two stereo-saponins 3-*O*-β-[{α-L-rhamnopyranosyl(1→2)-β-D-apiofuranosyl (1→6)}-β-D-glucopyranosyl]rosaterol and 3-*O*-β-[{α-L-rhamnopyranosyl (1→2)-β-D-xylopyranosyl}-β-D-glucopyranosyl]rosaterol have been isolated from *M. conica* (236). 1-Octen-3-ol was detected in the aroma extract of *M. conica* (237). *M. conica* was found to contain three carotenes, including δ-carotene as well as five xanthophylls (238).

Biological properties

Ethanol extract of *M. conica* was found to be anti-oxidant as well as antimicrobial (239).

Morina polyphylla

Morina polyphylla Wall. ex DC. (Gurung language: *Changshar*) belongs to the family Dipsacaceae. It is distributed in the Himalayan region (Garhwal to Bhutan) at the elevation range of 3000 to 4300 meter.

Traditional use in Manang

Powdered root is taken with hot water in conditions related to edema, stomachache, headache, diarrhea, dysentery, excessive bleeding during childbirth, body pain and numbness of the limb.

Chemical constituents and biological properties

Chemical and biological studies are lacking in this plant.

Myricaria rosea

Myricaria rosea W.W. Sm. (Synonym: *Myricaria germanica* var. *prostrata* Dyer) (Gurung language: *Angmeo*) belongs to the family Tamaricaceae. It is distributed in the Himalayan region (Kumaun to Bhutan), south Tibet and west China at the altitude range of 3300 to 4500 meter.

Traditional use in Manang

Pounded stems, leaves and flowers are boiled with water. This decoction is useful for respiratory diseases such as asthma, bronchitis and heavy breathing. Alternatively, powdered stems, leaves and flowers are mixed with hot water and is taken. For livestock suffering respiratory diseases, small pieces of stem, leaves and flowers are cooked with wheat flour and some salt. The cooked food is given to eat.

Chemical constituents

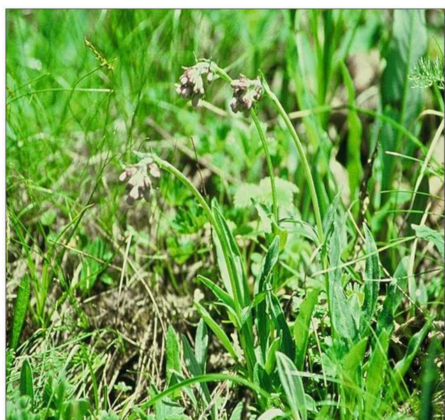
In the leaf cuticular waxes of *M. germanica* L., four different series of alkanediols were identified (240).

Biological properties

M. germanica forms a part of several patented traditional medicinal formulations. These include formulation for reducing tumor mass (241), Tibetan medicinal composition with therapeutic and heath care effects (242), Tibetan medicinal composition for treating acute and chronic sprain and contusion, rheumatic and rheumatoid diseases (243), pharmaceutical composition for treating bone and joint diseases (244), pharmaceutical composition for treating rheumatic and rheumatoid diseases (245), prophylactic and therapeutic compositions for fatigue (246) and the preparation of medical toothpaste (247).

Nardostachys grandiflora

Nardostachys grandiflora DC. (Synonym: *Nardostachys jatamansi* DC.) (Gurung language: *Panghphoie*) belongs to the family Valerianaceae. It is available in the Himalayan region (Garhwal to Bhutan), Tibet and west China at the elevation range of 3200 to 5000 meter.



Nardostachys grandiflora

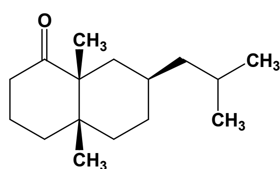
Traditional use in Manang

Powdered plant is mixed with another two herbs *Aconitum naviculare* and *Betula utilis* together with yak (*chauri*) ghee (clarified butter without any solid milk particles or water). This mixture is useful for diarrhea and fever. Powdered root when taken with hot water is good for gastritis, headache, edema, dyspepia and rib pain. It is also antihelmintic. Powdered root is placed in burning coal and its scent is useful for conjunctivitis (swollen, red and dirty eye).

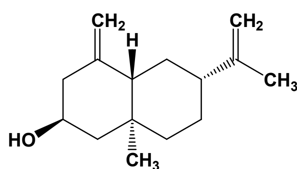
Chemical constituents

In the essential oil of the roots of *N. grandiflora*, five compounds, nardostachnol (9-aristolen-1α-ol), Δ9,10-aristolene, Δ1,10-aristolene, β-maaliene and 1,2,9,10-tetradehydroaristolene were identified (248). In the essential oil of the rhizome of *N. jatamansi* purchased in Kathmandu market, fifteen compounds were identified of which thirteen were sesquiterpenes and one each aromatic and coumarin

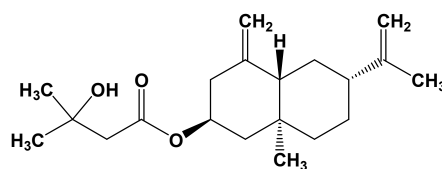
derivatives. Two major constituents in this essential oil were β-gurjunene (29.1%) and jatamansone (9.7%) (249). *N. jatamans*i rhizome essential oil from the Indian Himalayas contained nine monoterpenes (1.7%), 25 sesquiterpenes (43.9%) and 7 non-terpenic components (24.4%). The major sesquiterpenes include nardol (10.1%), α-selinene (9.2%), β-caryophyllene (3.3%), cubebol (2.9%), α-gurjunene (2.5%), γ-gurjunene (2.3%) and α-humulene (2.3%) (250). Sesquiterpenes such as jatamols A and B (251), nardin (252), terpenoid ester, nardostachysin (253), spirojatomol (254), seychellene and seychelane (255) and norseychelanone, α- and β-patchoulenes and patchouli alcohol (256) were also obtained from its rhizome. Furthermore, neolignans and lignans have also been reported from *N. jatamansi* roots (257). The structures of jatamansone and jatamols A-B are presented below.



jatamansone



jatamol A



jatamol B

Biological properties

N. jatamansi rhizome essential oil is fungistatic (258), antimicrobial (259) and nematicidal (260). The essential oil obtained from *N. grandiflora* inhibited mycelial growth of *Alernaria brassicicola* (35). *N. jatamansi* rhizome is shown to be hepatoprotective (261). It also possessed protective effect in the rat cerebral ischemia (262). The ethanol extract of whole plant of *N. jatamansi* increased HDL-cholesterol/total cholesterol ratio and decreased total cholesterol/phospholipids ratio (263). *N. jatamansi* helped improve learning and memory in rats (264). *N. jatamansi* was found to play cytoprotective role in doxorubicin induced cardiac damaged rats (265). The ethanol extract of *N. jatamansi* displayed cytotoxic activity (IC_{50} < 30 μg/mL) against lung and prostate cancer cell lines (266). *N. jatamansi* showed antiarrhythmic activity (267). Valeranone, a compound isolated from *N. jatamansi* prolonged barbiturate anesthesia, inhibited electroshock convulsions and potentiated the hypothermic effects of reserpine in mice and rats. It also contained antiulcerogenic activity and a weak hypotensive effect (268). The ethanol extract of *N. jatamansi* roots has been found to be helpful in attenuating 6-hydroxydopamine-induced Parkinsonism in rats (269). The ethanol extract of *N. jatamansi* produced significant antidepressant-like effect in Swiss young albino mice in both tail suspension and forced swim tests (270). Jatamansone, a sesquiterpene obtained from *N. jatamansi*, is shown to have antiarrhythmic and anticonvulsant (271) as well as tranquillizing (272) activities.

Neopicrorhiza scrophulariiflora

Neopicrorhiza scrophulariiflora (Pennell) Hong (Synonym; *Picrorhiza scrophulariiflora* Pennell) (Gurung language: *Kutki*) belongs to the family Scrophulariaceae. It is

distributed in Nepal, Bhutan, China, north India and north Myanmar at the elevation range of 3500 to 4800 meter.



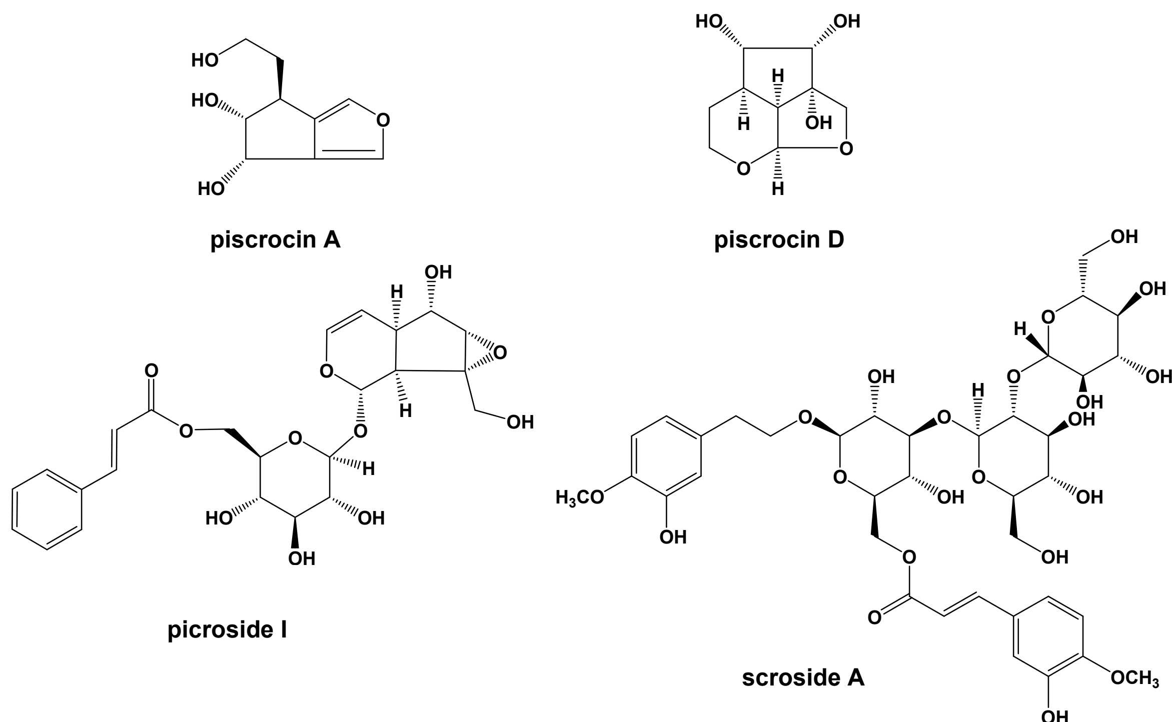
Neopicrorhiza scrophulariiflora

Traditional use in Manang

Root is pounded on a stone slab and is boiled with water. The decoction is mixed with milk and is orally taken. This treatment is useful for the conditions related to typhoid, malaria, jaundice, diarrhea, paralysis, stomachache, dyspepsia, heart disease, snakebite and scorpion sting. Alternatively, powdered root is taken with yak (*chauri*) ghee. Root paste finds application in cuts, wounds, scabies, snakebite and scorpion sting.

Chemical constituents

Major isolated compounds from this plant fall in the categories of iridoids, cucurbitacin glycosides and phenyl ethanoid and propanoids. A cucurbitacin glycoside 2β-glucopyranosyloxy-3, 16, 20, 22-tetrahydroxy-9-methyl-19-norlanosta-5, 24-diene, together with three iridoid glycosides, amphicoside (picroside-II), catalpol, aucubin and a phenol glycoside, androsin were isolated from the roots of *P. scrophulariiflora* (273). The underground parts of *P. scrophulariiflora* afforded three phenylethanoid glycosides, scrosides A, B and C and an iridoid glycoside, picroside IV (274). Non-glycosidic iridoids such as piscrocins A, B and C (275) as well as piscrocins D, E, F and G (276) have also been obtained from this plant. Two iridoid glucosides with 3,4-dihydrocatalpol skeleton, piscrosides A and B were obtained from *P. scrophulariiflora* (277). Further isolated iridoid glucosides include picrorosides A, B and C (275). Phenylethanoid and phenolic glycosides such as 2-(3,4-dihydroxyphenyl)-ethyl-*O*-β-D-glucopyranoside, plantainoside, scroside A, scroside B, scroside D, piceoside, 6-*O*-feruloyl-β-D-glucopyranoside and 2-(3-hydroxy-4-methoxyphenyl)-ethyl-*O*-β-D-glucopyranosyl(1$\rightarrow$3)-β-D-glucopyranoside, have also been isolated from *P. scrophulariiflora* roots (278). From the stems of *P. scrophulariiflora*, three phenyl glycosides, scrophenoside A, B, and C and two phenylethyl glycosides, scroside D and scroside E were obtained (279). A phenyl glycoside, scrophenoside D and a phenylethyl glycoside, scroside F have also been obtained from *P. scrophulariiflora* (280). Among the isolated cucurbitacin glycosides include 2-*O*-β-D-glucopyranosyl-3,16,20,25-tetrahydroxy-9-methyl-19-norlanosta-5,23-diene-22-one, 2-*O*-β-D-glucopyranosyl-3,16,20-trihydroxy-25-acetoxy-9-methyl-19-norlanosta-5,23- diene- 22-one and 2-*O*-β-D-glucopyranosyl-4,4,9,14-tetramethyl-19-norpregn-5-en-20-one (281). The underground parts of *P. scrophulariiflora* has furnished three caffeoyl glycosides, scrocaffesides A, B and C together with two caffeic acid derivatives, 4-*O*-β-D-glucopyranosyl caffeic acid and 4-methoxycaffeic acid (282). The structures of three iridoids and one phenylethanoid glycoside isolated from the plant are presented below.



Biological properties

P. scrophulariiflora rhizome extracts are described as having immunomodulatory and anti-inflammatory activities (283). Total glycosides present in *P. scrophulariiflora* represented the active ingredient responsible for the antioxidant effect. These glycosides had the potentiality to protect mesangial cells against oxidative stress induced by high glucose (284). The methanol extract of *P. scrophulariiflor*a possessed superior nerve growth factor-potentiating activity (285). Picrosides I and II isolated from its rhizome were found to be nerve growth factor-potentiating compounds (286).The iridoids isolated from *N. scrophulariiflora* had hepatoprotective activities (276). Picroside II protected hepatocytes against injury and prevented hepatocytes from apoptosis (287). Scroside D, 2-(3,4-dihydroxyphenyl)-ethyl-O-*β*-D-glucopyranoside and plantainoside D were found to be potent antioxidant (278). The compound plantainoside D was determined to be a potential candidate agent for protecting cardiotoxicity in adriamycin-exposed patients (288). Two cucurbitacin aglycons, picracin and deacetylpicracin, obtained from *N. scrophulariiflora* brought about inhibition of mitogen-induced T-lymphocyte proliferation at an IC_{50} value of 1 μM (289).

Onopordum acanthium

Onopordum acanthium L. (Gurung language: *Mangh*) belongs to the family Compositae. The plant is distributed in Asia, north America and Europe.

Traditional use in Manang

Root is pounded on a stone slab and is boiled with water. This decoction is diuretic and dysuriac. Alternatively, powdered root is boiled with water.

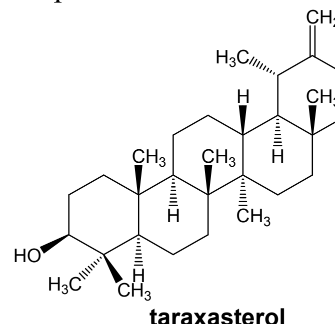

Onopordum acanthium

Chemical constituents

Triterpene, taraxasterol, is abundandly present in the leaves of *O. acanthium* but it was found in lesser quantity in the stem and floral base. Taraxasteryl acetate was detected on all these three parts of the plant (290). Onopordopicrine, a sesquiterpenic lactone, was obtained from *O. acanthium* (291). Glycosides of quercetin, luteolin, isorhamnetin, and apigenin were found in *O. acanthium*. Caffeic acid esters, choline and stachydrine were also isolated (292). The plant also contained 1-amino-2-propanol (293). In its oil, fatty acids were 72% linoleic, 21% oleic, 4% palmitic, and 2% stearic and traces of myristic, palmitolinoleic, eicosanoic, and eicosenoic acids. The nonsaponifiable fraction contained phytosterols and provitamins A and D (294). Several oxygenated fatty acids (295) and oxygenated triacylglycerols (296) were also obtained from lipid fraction of *O. acanthium* seeds. The structure of taraxasterol is presented below.

Biological properties

O. acanthium stem and leaves aqueous extracts showed intermediate augmentation of splenic natural killer (NK) cells (38.6% +/- 3.8% cytotoxicity) (297). Taraxasteryl acetate is reported to possess anti-inflammatory properties (298). Taraxasterol acted as chemopreventive agent against chemical carcinogenesis (299) and possessed antimicrobial (300) and antihypolipidemic (301) activities.



taraxasterol

Origanum vulgare

Origanum vulgare L. (Gurung language: *Akhebobo*) is a member of Labiatae family. It is found in the altitude range of 600 to 4000 meter throughout Europe, Asia and north America

Traditional use in Manang

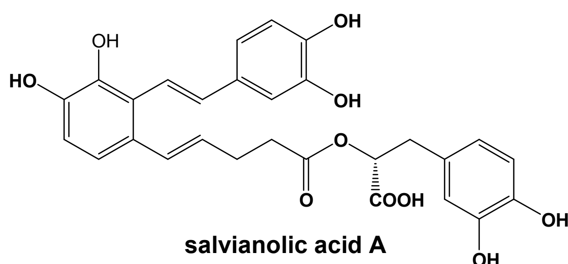
Either pounded or powdered whole plant is taken with boiled water for cold & cough, high blood pressure, fever and heart diseases.

Chemical constituents

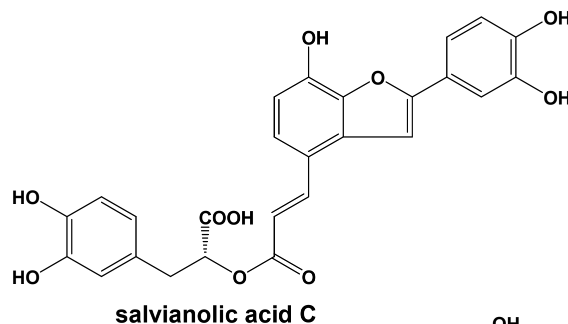
Thymol and carvacrol are main components of the volatile oil of *O. vulgare* (302). However, the essential oil of *Origanum vulgare* L. collected from north India had linalool (23.8%), myrcene (18.0%), β-caryophyllene (9.06%), germacrene-D (7.4%) and terpinen-4-ol (4.4%) as the major compounds (303). In one another study, the major components of the volatile oil in *O. vulgare* were found to be thymol (58.43%), carvacrol


Origanum vulgare

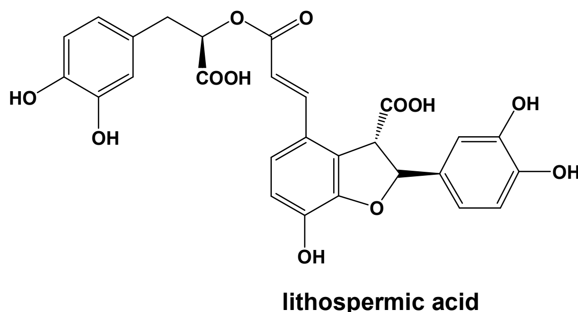
(19.29%), isohexane (2.74%), methyl carvacryl ether (2.67%), geranylacetone, methyl thymyl ether (0.73%) and *p*-cymene (0.34%) (304). Several essential oils of all aerial parts, inflorescences and leaves of cultivated *O. vulgare* were analyzed. The inflorescence essential oils were found to contain sabinene (8.7-19.5%), *β*-caryophyllene (15.4-24.9%) and germacrene D (12.3-16.0%) where as the leaf essential oils contained *β*-caryophyllene (15.9-21.3%), germacrene D (12.1-15.7%) and caryphyllene oxide (4.7-11.1%) (305). The major fatty acids present in the seeds of *O. vulgare* include linolenic, linoleic, oleic, palmitic, stearic and (*Z*)-11-octadecenoic (306). Polyphenolic compounds such as salvianolic acid A , salvianolic acid C, lithospermic acid, apigenin 7-*O*-*β*-D-glucuronide, apigenin 7-*O*-*β*-D-(6''-methyl)glucuronide, luteolin 7-*O*-*β*-D-glucopyranoside, luteolin 7-*O*-*β*-D-glucuronide, luteolin 7-*O*-*β*-D-xylopyranoside and a dihydrobenzodioxane derivative, origalignanol, were isolated from the aquoues ethanolic extract of the aerial parts of *O. vulgare* (307).The isolated phenolic acids from *O. vulgare* include cinnamic, *p*-hydroxy-benzoic, vanillic, syringic, protocatechuic, caffeic and chlorogenic acids (308). Flavonoids such as luteolin, apigenin, peonidin, naringin, and catechol have been detected in *O. vulgare* (309). An antioxidative phenolic acid, 2-caffeoy- loxy-3-[2-(4-hydroxybenzyl)-4,5-dihydroxy]phenylpropionic acid (310) as well as a glucoside, 4-(3,4-dihydroxybenzoyloxymethyl)phenyl4-(3,4-dihydroxybenzoyloxymethyl)phenyl-*β*-D-glucopyranoside (311) have also been obtained from the leaves of *O. vulgare*. The structures of some isolated polyphenolics are given below.



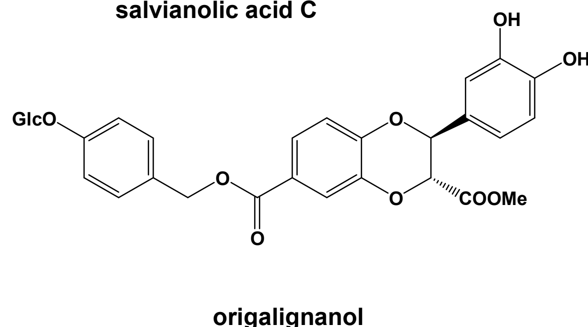
salvianolic acid A



salvianolic acid C



lithospermic acid



origalignanol

Biological properties

O. vulgare essential oil is found to be antimicrobial. The oil obtained from the leaf was more active than the oil obtained from inflorescence (312). Thymol and carvacrol, constituents of the essential oil of *O. vulgare*, exerted moderately strong bacteriostatic and bactericidal effects on dysentery bacteria and common bacteria causing enteritis (313). *O. vulgare* subsp. *Hirtum* essential oil is fungicidal (314). *O. vulgare* essential oil was also found to inhibit the growth of food spoiling yeasts (315). The essential oil of *O. vulgare* subsp. *Hirtum* displayed high level of antimicrobial activity as well as high levels of cytotoxicity against four permanent animal cell lines, including two derived from human cancers (316). *O. vulgare* water extract exhibited an anti-hyperglycaemic activity in STZ rats without affecting basal plasma insulin concentration (317). *O. vulgare* essential oil as well as thymol and carvacrol present in the essential oil prevented the formation of toxic products by the action of reactive nitrogen species (318). *O. vulgare* extract had antioxidant and anti-inflammatory activities (319). Salvianolic acid A, salvianolic acid C and lithospermic acid isolated from *O. vulgare* showed strong DPPH radical scavenging activity and protected hepatocytes in CCl_4 damaged rats (307). Aristolochic acid I and aristolochic acid II obtained from *O. vulgare* had high inhibition of thrombin activity and were shown to possess anticancer activity (320).

Paris polyphylla

Paris polyphylla Sm. (Gurung language: *Satuwa*) belongs to the family Liliacea. It is distributed in Bhutan, India, Laos, Myanmar, Nepal, Sikkim, Thailand, Vietnam and China at the elevation range of 100 to 3500 meter.



Paris polyphylla

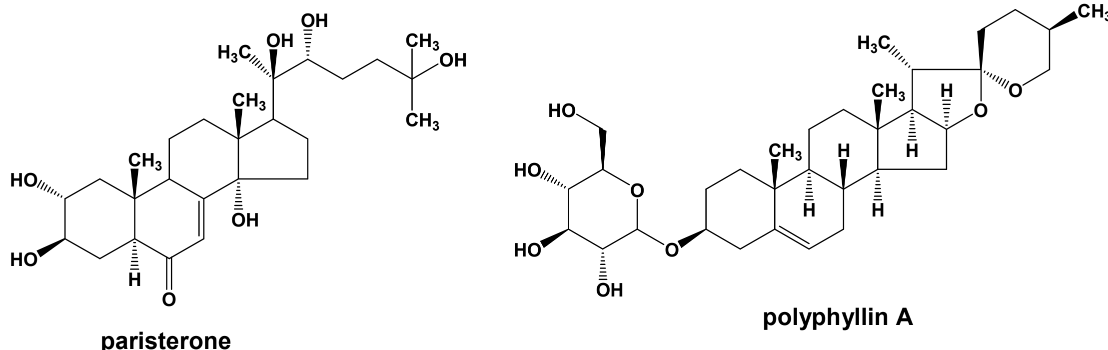
Traditional use in Manang

Powdered stems, leaves and flowers in hot water are useful in getting rid of worms. It is recommended to take herbal tonic along with this medicine.

Chemical constituents

P. polyphylla is a rich source of diverse steroid saponins. The plant has been identified as a new source of diosgenin (321). A phytoecdysone called paristerone has been isolated from the tuber of *P. polyphylla* (322). *P. polyphylla* tubers contained saponins such as pariphyllin, diosgenin-3-*O*-α-L-rhamnopyranosyl(1 $\rightarrow$ 4)-α-L-arabinofuranosyl-(1 $\rightarrow$ 3)-β-D-glucopyranoside (323), Diosgenin 3-*O*-α-L-rhamopyranosyl-(1 $\rightarrow$ 2)-[α-L-arabinofuranosyl-(1 $\rightarrow$ 4)]-β-D-glucopyranoside, diosgenin 3*O*-αL-rhamnopyranosyl-(1 $\rightarrow$ 4)-α-L-rhamnopyranosyl-(1 $\rightarrow$ 4)-[α-L-rhamnopyranosyl-(1 $\rightarrow$ 2)]-β-D-glucopyranoside pregna-5,16-dien-3β-ol-20-one 3-*O*-β-chacotrioside, dioscin (diosgenin 3-*O*-β-chacotrioside) (324) pariphyllin A and B (325) polyphyllin A, B, C, D, E, F, G and H (326) (23*S*, 25*S*)-3β, 23, 27-trihydoxyspirost-5-en-3-*O*-β-D-glucopyranosyl-(1$\rightarrow$6)-β-D-glucopyranoside, paris saponin I, paris saponin II, (25*R*) diosgenin-3-*O*-β-D-glucopyranoside, (25*R*) diosgenin-3-*O*-α-L-arabinofuranosyl(1$\rightarrow$4)-β-D-glucopyranoside, (25*R*) diosgenin-3-*O*-α-L-

rhamnopyranosyl(1→2)-*β*-D-glucopyranoside, (25*R*) diosgenin-3-*O*-*α*-L-glucopyranosyl -(1→3)[α-L-rhamnopyranosyl(1→2)]-*β*-D-glucopyranoside, (25*R*) pennogenin-3-*O*-*α*-L-arabinofuranosyl(1→4)[*α*-L-rhamnopyranosyl(1→2)]-*β*-D-glucopyranoside (327). The structures of paristerone and polyphyllin A are presented below.



Biological properties

P. polyphylla is found to contain antioxidant activity (328). *P. polyphylla* var. *chinensis* and *P. polyphylla* var. *yunnanensis* had strong analgesic action. *P. polyphylla* var. *chinensis* was also found to be potent sedative (329). *P. polyphylla* aqueous extract showed a moderate antimutagenic activity against picrolonic acid and benzo[a]pyrene-induced mutations (330). *P. polyphylla* extract is shown to contain spermicidal activity in rat and human sperms (331). The methanol extract of the rhizomes of *P. polyphylla* Sm. var. *yunnanensis* was found to potently inhibit ethanol-induced gastric lesions in rats. Based on bioassay directed fractionation, four spirostanol-type steroid saponins were isolated. The isolated saponins strongly inhibited gastric lesions induced by ethanol and indomethacin (332). The antitumor saponins have been isolated from the rhizome of *P. polyphylla* var. *yunnanensis* (333). Polyphyllin D isolated from *P. pollyphyla* has a strong apoptosis inducer in drug-resistant HepG2 cells making it a potent anticancer agent (334). Polyphyllin D was also found to inhibit human breast cancer cells (335). Diosgenin type saponins isolated from *P. polyphylla* rhizomes were demonstrated to be tyrosinase inhibitors as well as antileishmanial agents (336). Furthermore, immuno-stimulating diosgenyl saponins are also reported to have been isolated from *P. polyphylla* (337).

Pinus wallichiana

Pinus wallichiana A.B. Jacks. (Gurung language: *Thansin*) belongs to the family Pinaceae. It is found in Afghanistan, the Himalayan region and south east Tibet at around 4300 meter.

Traditional use in Manang

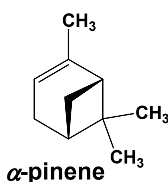
Pieces of the bark are used on the fractured portion of the body. Latex is used on the skin abrasion. Powdered bark together with milk is taken to treat tuberculosis (symptoms include blood vomiting, dizziness and fever.)



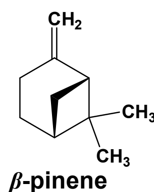
Pinus wallichiana

Chemical constituents

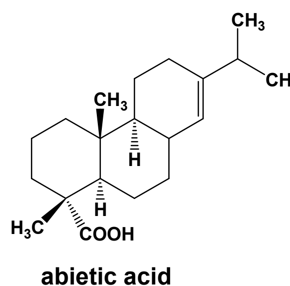
P. wallichiana yielded rosin (84%) and turpentine oil (16%). Turpentine oil contained 89% α-pinene and 4.4% β-pinene as major constituents and rosin contained abietic acid (70%) (338). Furthermore, isomers of undecane, dodecane and tridecane and some sesquiterpenes as minor components were detected in turpentile oil where as rosin contained isopimaric acid and lambertianic acid as well (339). Its bark contains 12.2% tannin (340). The structures of the compounds present in turpentine oil and rosin are presented below.



α-pinene



β-pinene



abietic acid

Biological properties

It forms a part of patented skin preparation formulation with anti-wrinkling properties (341).

Polygonatum cirrhifolium

Polygonatum cirrhifolium (Wall.) Royle (Gurung language: *Gomesha*) belongs to the family Liliaceae. It is available in the Himalayan region (Punjab to Bhutan), Manipur, south Tibet and west China at the altitude range of 1700 to 4600 meter.

Traditional use in Manang

Either decoction of powdered whole plant or powdered whole plant with boiled water is taken to treat cold & cough and fever. Powdered whole plant with milk is considered an aphrodisiac.

Chemical constituents

Steroid saponins have been isolated from *P. cirrhifolium* rhizome. Two steroid saponins, (25*R*)-spirost-5-ene-3β-ol-3-*O*-α-L-rhamnopyranosy (1 $\rightarrow$2)-[α-L-rhamnopyranosyl(1 $\rightarrow$4)]-β-D-glucopyranoside and (25*R*)-spirost-5-ene-3β-ol-3-*O*-α-L-rhamnopyranosyl-(1 $\rightarrow$ 4)-β-D-glucopyranoside have been isolated (342). Similarly, (25*R*)-spirost-5-ene-3β-ol-3-*O*-α-L-rham-nopyranosy(1$\rightarrow$ 2)-[α–L-rhamnopyranosyl(1$\rightarrow$4)]-β-D-gluco-pyranoside, (25*R*)-spirost-5-ene-3β-ol-3-*O*-α-L-rhamnopyranosyl(1$\rightarrow$4)-β-D-gluco-

pyranoside, dauvosterol, β-sitosterol, (*Z*)-6-nonadecenoic acid, (*Z*)-6-stearic acid and one inorganic compound were obtained from the plant (343).

Biological properties

P. cirrhifolium extracts had fungicidal activities (344). Steroid saponins, (25*R*)-spirost-5-ene-3β-ol-3-*O*-α–L-rham-nopyranosy(1 → 2)-[α-L-rhamnopyranosyl(1 →4)]-β-D-glucopyranoside and (25*R*)-spirost-5-ene-3β-ol-3-*O*-α-L-rhamnopyranosyl(1 → 4)-β-D-glucopyranoside and the aglicons showed strong inhibition against plant pathogenic fungi as well as strong inhibition against bacterial growth (342). The plant forms a part of patented anti-AIDS Ayurvedic formulation (345).

Rheum moorcroftianum

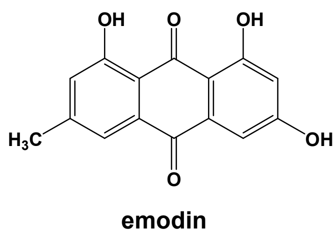
Rheum moorcroftianum Royle (Gurung language: *Khajo*) belongs to the family Polygonaceae. It is found in the Himalayan region (Kumaun to Nepal) at the elevation range of 3600 to 4400 meter.

Traditional use in Manang

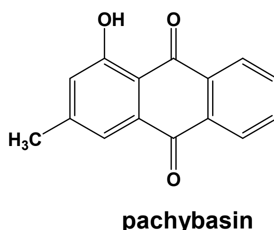
Crushed stems are mixed with chili, salt and other spices to prepare pickles. The pickle is said to increase and purify blood.

Chemical constituents

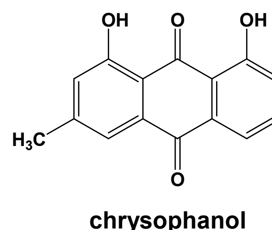
Anthraquinone derivatives are the major components of this plant. From the rhizome of *R. moorcroftianum*, chrysophanol, physcion, chrysophanol 8-*O*-β-D-glucopyranoside and emodin 8-*O*-β-D-glucopyranoside have been isolated (346). Rhizome has also afforded emodin, pachybasin, β-sitosterol and β-sitosterol-D-glucoside (347). The structures of some anthraquinone derivatives obtained from *R. moorcroftianum* are presented below.



emodin



pachybasin



chrysophanol

Biological properties

Chrysophanol and emodin have been found to possess mild spermicidal activity against human spermatozoa (347). Emodin as well as other anthraquinone derivatives are well known laxative agents and display a wide variety of biological properties (348).

Rhododendron anthopogon

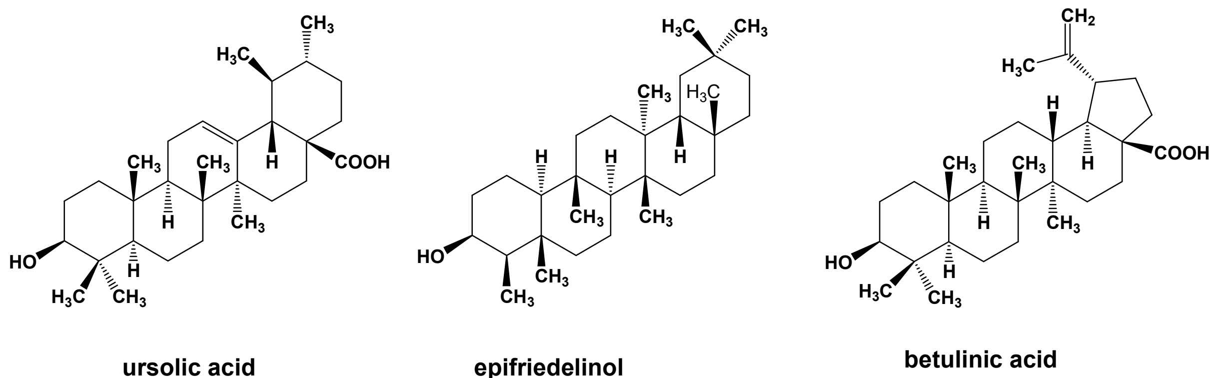
Rhododendron anthopogon D. Don (Gurung language: *Palu*) belongs to the family Ericaceae. It is found in east Asia, west China and the Himalayan region at the altitude range of 3000 to 4500 meter, occasionally at the range of 5000 meter as well.

Traditional use in Manang

Powdered leaves and flowers are taken either with milk or with hot water for complications arising from high blood pressure, paralysis, limb and waist pain and fever. Powdered leaves and flowers are placed on burning coal and the patients suffering from above mentioned disease are allowed to smell the scent.

Chemical constituents

Triterpenoids, flavonoids and sterols are the major constituents of *R. anthopogon*. From the whole plant of *R. anthopogon*, methylene-24-cycloartenyl acetate, ursolic acid acetate, epifriedelinol, β-sitosterol, ursolic acid, betulinic acid and rutin have been isolated (349). Moreover, four flavonoids namely kaempferol, kaempferol 4-methyl ether, kaempferol 3-*O*-β-D-glucopyranoside and quercetin 3-*O*-α-L-rhamnopyranoside were obtained from its leaves (350). The structures of three isolated triterpenoids are presented below.



Biological properties

R. anthopogon is found to possess potent antimicrobial activity against *Trichophyton mentagrophytes* (351). Its ethanol extract is said to be stimulant (352). It forms a part of traditional Chinese traditional medicinal formulation for relaxing uterus and alleviating dysmenprrhea (353) and for uterine relaxing in women's menstruation pain relief (354). Its essential oil which contained β-cadinene (11.4%) as the major constituent was found to be antimicrobial (355).

Rhododendron lepidotum

Rhododendron lepidotum Wall. ex G. Don (Gurung language: *Bhaiunakpo*) belongs to the family Ericaceae. It is distributed in Kashmir (India), Nepal, Bhutan, south Tibet, north west Yunnan and north Myanmar at the elevation range of 3000 to 4000 meter.



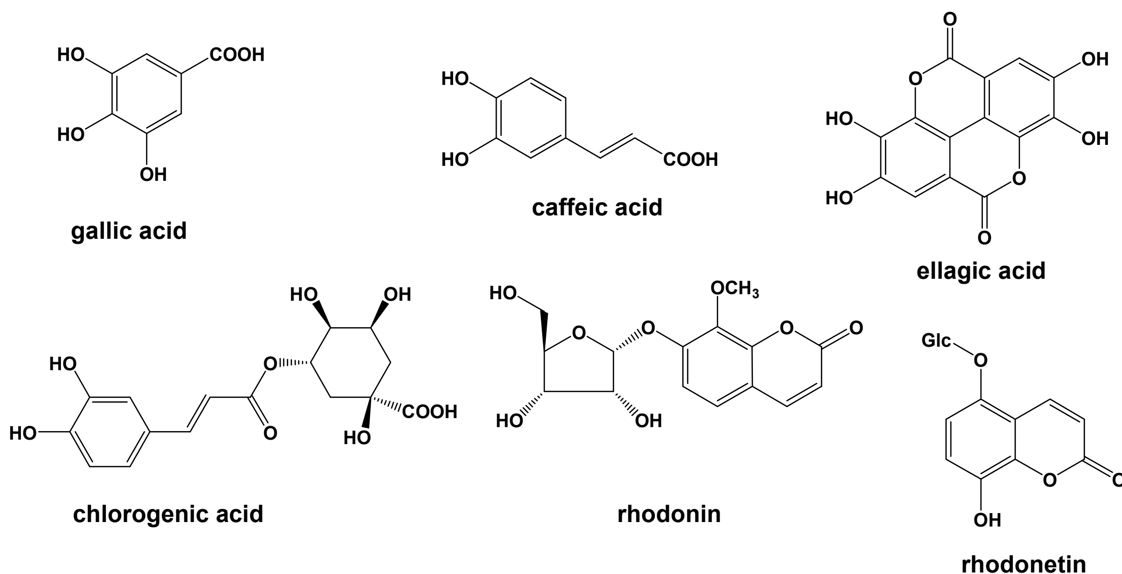
Rhododendron lepidotum

Traditional use in Manang

Paste made from fresh leaves and flowers are useful to purify blood. Powdered leaves and flowers together with other herbs (unknown) are taken for the remedy of cold and cough, fever and tonsillitis.

Chemical constituents

R. lepidotum is shown to contain phenolic acids such as gallic, caffeic, chlorogenic, ellagic and protocatechuic as well as a flavonoid, quercetin (356). Two coumarin glucosides, rhodonin and rhodonetin, have also been isolated from the aerial parts of *R. lepidotum* (357). The structures of phenolic acids and coumarin glucosides isolated from this plant are presented below.



Biological properties

The plant extracts as well as the phenolic acids and flavonoids detected in the plants are found to be free radical scavengers with antioxidative properties (356), (358).

Rosa macrophylla

Rosa macrophylla Lindl. (Gurung language: *Seghu*) belongs to the family Rosaceae. It is found in the Himalayan region (Kashmir to Sikkim) and China (south Xizang and north east Yunnan) at the elevation range of 3000 to 3700 meter.

Traditional use in Manang

Powdered fruit is taken with hot water for cold & cough, fever, diarrhea and dysentery.



Rosa macrophylla

Chemical constituents

R. macrophylla has been reported to contain high amount of vitamin C and carotene (359).

Biological properties

R. macrophylla flower showed moderate antiviral activity against influenza A virus (15).

Rosa sericea

Rosa sericea Lindl. (Gurung language: *Sewa*) belongs to the family Rosaceae. It is distributed in the Himalyan region (Chamba to Bhutan), Tibet, Assam, north Myanmar and west China at the elevation range of 2200 to 4600 meter.



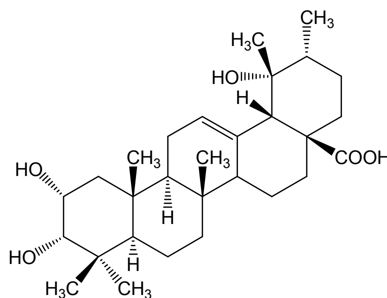
Rosa sericea

Traditional use in Manang

Powdered fruit is taken with hot water for the conditions related to diarrhea, dysentery, stomachache, dyspepsia and bile disorder. Dried or fresh petal in hot water is useful for reducing blood pressure. Powdered fruit pulp is used to treat gingivitis.

Chemical constituents

In the fruits of *R. sericea*, six compounds namely euscaphic acid, euscaphic acid 2,3-monoacetonide, 4-*O*-*β*-D-glucopyranosyl methyl gallate, quercetin, oleanolic acid and stigmasterol were identified (360). The structure of euscaphic acid is presented below.



euscaphic acid

Biological properties

A procedure to prepare wine from the fruits of *R. sericea* has been patented (361).

Rubus foliolosus

Rubus foliolosus D. Don (Gurung language: *Mapalan*) is a member of the family Rosaceae. It is found in the Himalayan region (Simla to Nepal) and west China at the altitude range of 2100 to 2900 meter.



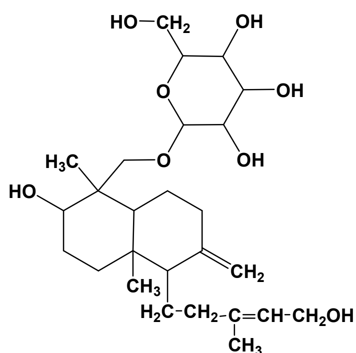
Rubus foliolosus

Traditional use in Manang

Pounded root is boiled with water. This decoction is useful for cold & cough, headache, fever, dyspepsia, tonsillitis, vertigo/dizziness, and enervate period. Alternatively, powdered root is taken with hot water.

Chemical constituents

Its fruits have afforded seven labdane-type diterpene gjucosides, goshonosides-F 1-7 (362). The structure of goshonosides-F 2 is given below.



goshonoside-F 2

Biological properties

Nutrient contents of the fruits of *R. foliolosus* growing wild in Nepal have been determined (363).

Rumex nepalensis

Rumex nepalensis Spreng. (Gurung language: *Hali*; Amchi term: *Lungsho*) belongs to the family Polygonaceae. It is distributed in south west Europe, west Asia, the Himalayan region, China and Japan at the altitude range of 1200 to 4200 meter.



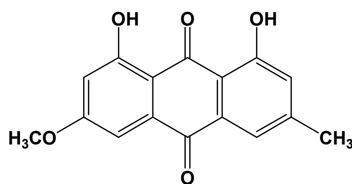
Rumex nepalensis

Traditional use in Manang

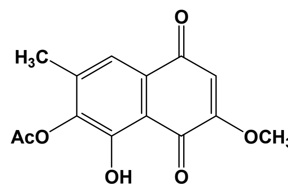
Decoction of the pounded root is taken for the remedy of fever. Grounded root powder is used for the conditions related to cold & cough, gingivitis, joint pain and stomachache.

Chemical constituents

Roots of *R. nepalensis* have afforded chrysophanol, emodin, physcion, chrysophanol-8-*O*-*β*-D-galactopyranoside, musizin-1-*O*-*β*-D-glucopyranoside, orientalone, 3-methoxy-5,6-methylenedioxybenzaldehyde, lupeol, *β*-sitosterol and *β*-sitosterol glucoside (364). Furthermore, 1,8-dihydroxy-3-methylanthraquinone, 1,6,8-trihydroxy-3-methyl anthraquinone, 1,8-dihydroxy-6-methoxy-3-methylanthraquinone together with lupeol and *β*-sitosterol were also isolated from the aerial part of *R. nepalensis* (365). The structures of one each of isolated anthraquinone and naphthaquinone derivatives are presented below.



physcion



orientalone

Biological properties

The methanol extract of *R. nepalensis* roots at the oral dose of 100-400 mg/kg is found to demonstrate significant and dose-dependent purgative activity (366). Aqueous and alcohol leaves extracts showed antihistaminic and anticholinergic properties (367). The methanol extract of *R. nepalensis* roots has been reported as having significant antibacterial properties (368). Several favourable psychopharmacological activities were found to be enhanced by *R. nepalensis* in rats and mice (369). Methanol and water extracts of *R. nepalensis* showed inhibitory effects against hepatitis C virus RNA-dependent RNA polymerase (370).

Salix serpyllum

Salix serpyllum Andersson (Gurung language: *Langmanackpo*) belongs to the family Salicaceae. It is distributed in the eastern Himalayan region (Nepal to Sikkim) at the elevation in around 4700 meter.

Traditional use in Manang
Powdered leaves and stem together with other herbs (unknown) are taken with hot water for the treatment of stomachache, diarrhea and dysentery.

Chemical constituents and biological properties
Chemical and biological studies are lacking in this plant.

Saussurea auriculata

Saussurea auriculata (DC.) Sch. Bip. (Gurung language: *Ta*) belongs to the family Compositae. It is distributed in the Himalayan region (Kashmir to Bhutan) at the altitude range of 3100 to 3800 meter.

Traditional use in Manang
Paste of pounded leaves and stems are applied to the part of body where blood circulation is thought to have been stopped. Slight heating is also done on the infected portion. It is believed that this plant is useful for blood circulation during winter season, especially for the older people.

Chemical constituents and biological properties
Chemical and biological studies are lacking in this plant.

Saussurea fastuosa

Saussurea fastuosa (Decne.) Sch. Bip. (Gurung language: *Singamindro*) belongs to the family Compositae. It is available in the Himalayan region (Kumaun to Sikkim), south Tibet, north Myanmar and south west China at the altitude range of 2900 to 3800 meter.

Traditional use in Manang
Its juice is used to stop bleeding from minor cuts.

Chemical constituents and biological properties
Chemical and biological studies are lacking in this plant.

Selinum wallichianum

Selinum wallichianum (DC.) Raizada & Saxena (Synonym: *Selinum tenuifolium* Wall. ex C. B. Clarke) (Gurung language: *Bhutkesh*; Amchi term: *Tanak*) belongs to the family Umbelliferae. It is distributed in the Himalayan region (Kashmir to Bhutan), Tibet and China at the elevation range of 2600 to 4200 meter.

Traditional use in Manang

Powdered leaves and flowers are taken with hot water to cure stomachache. The paste obtained from leaves and flowers is useful for cuts and wounds.

Chemical constituents

Furocoumarins such as bergapten, heraclenol, heraclenin, angelicin and xanthotoxol have been isolated from the roots of *S. tenuifolium* (371). Two dihydropyranocoumarins, isopteryxin and anomalin, were also obtained from the ether extract of the roots of *S. tenuifolium*. Alcohol extracts yielded sucrose and mannitol (372). Air-dried umbels of *S. tenuifolium* was found to contain isoimperatorin (0.56%), osthole (0.07%), imperatorin (0.036%) and oxypeucedanin (0.4%) where as its roots possessed oxypeucedanin (1.2%), isoimperatorin (0.07%), osthole (0.02%) and imperatorin (0.007%) (373). The root essential oil was shown to contain limonene, elemol, terpineol, geraniol and eudesmol (374). *S. tenuifolium* Wall. oil contained twenty-two compounds of which 3,5-nonadiyne (65.4%) and β-eudesmol (7.2%) were the major constituents. Its roots oil had sixteen constituents with 3,5-nonadiyne (89.7%) as the major components (375).

Biological properties

Fatty acids and their esters isolated from *S. tenuifolium* have been patented for their role as ganglioside metabolism accelerators (376).

Stellera chamaejasme

Stellera chamaejasme L. (Gurung language: *Rekemukta*; Amchi term: *Rechaya*) belongs to the family Thymelaeaceae. This plant is distributed in central Asia, the Himalayan region (Garhwal to Bhutan), Mongolia, east Siberia and north China at the elevation range of 2700 to 4200 meter.



Stellera chamaejasme

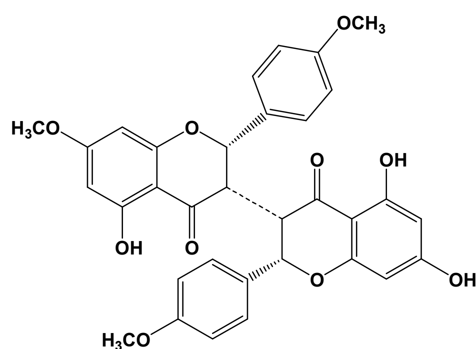
Traditional use in Manang

The root paste is applied on the fractured bones. It is also used as an antiseptic on the cuts and wounds. The root decoction is useful for the patients suffering from fractured bones and edema. Powdered dried root is taken with hot water for the treatment of infectious diseases.

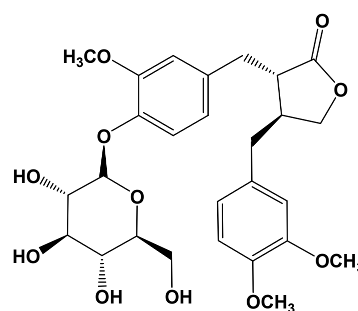
Chemical constituents

Various classes of compounds such as lignans, phenylpropanoids, flavonoids, diterpenes, coumarins, biflavones and others have been obtained from the plant. A host of biflavonoids were found in *S. chamaejasme*. Its roots is shown to contain chamaejasmenins (A–D), isochamaejasmenin B, neochamaejasmin A and sikokianin A (377), isoneochamaejasmin A (378), stelleranol (379), wikstrol A and neochamaejasmin B (380) wikstrol B, dihydrodaphnodorin B, daphnodorin B, isochamaejasmin, and neochamaejasmin B (381) 7-methoxyneochamaejasmin A (382) and ruixianglangdusu A–B (383). Lignans such as lappaol F, clemastanin B, arctiin, and matairesinol have also been obtained (384). Other lignans isolated were kusunokinin,

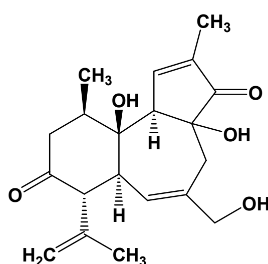
lirioresinol-B, magnolenin C, (−)-pinoresinol monomethyl ether, (−)-pinoresinol, (+)-matairesinol, isohinokinin and (−)-eudesmin (383). Its leaves essential oil had fourty-two components of which eighteen were identified. One of them was *N,N*-diphenyl-hydrazinecarboxamide which is suspected to be the source of irritative odor of the leaves (385). Furthermore, umbelliferone 7-*O*-*β*-D-glucopyranoside, umbelliferone, syringin, syringinoside, pinoresinol 4,4'-*O*-bis-*β*-D-glucopyranoside, matairesinol, betulinic acid and octadecoic acid have also been isolated from *S. chamaejasme* (386). Its roots afforded more compounds such as *β*-sitosterol, simplexin, pimelea factor P2, daucosterol, (+)-3-hydroxy-1,5-diphenyl-1-pentanone, 4-ethoxybenzoic acid, 2,4,6-trimethoxybenzoic acid (III), (+)-afzelechin, fumaric acid, *N,N*-dimethyl-*L*-aspartic acid, umbelliferone and daphnoretin (387). Two compounds, 1,5-dipheny-1-pentanone and 1,5-diphenyl-2-penten-1-one were also obtained from its roots (388). Chromone derivatives such as isomohsenone (389) and coumarin glycoside (390) as well as a bicoumarin named bicoumastechamin (387) were also isolated from its roots. A diterpenoid, neostellerin (391) as well as a daphnane type diterpene (390) were isolated from the roots of *S. chamaejasme*. The structures of representative isolated compounds are presented below.



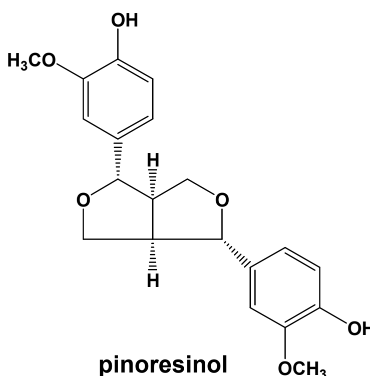
ruixianglangdusu A



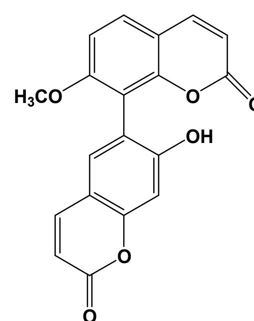
arctiin



neostellerin



pinoresinol



bicoumastechamin

Biological properties

The methanol and ethylacetate extracts of crushed root of *S. chamaejasme* possessed significant fungicidal activity. Two antifungal compounds neochamaejasmine B and chamaechromone were isolated from the ethylacetate extract (392). Compounds such as 1,5-diphenyl-1-pentanone and 1,5-diphenyl-2-penten-1-one obtained from *S.*

chamaejasme displayed strong insecticidal activity against *Aphis gossypii* Glov. (393). Chamaejasmenin D, isochamaejasmenin B and chamaejasmenin A demonstrated potent antimitotic and antifungal activity with minimum inhibitory concentration values of 6.25, 6.25, and 3.12 μg/mL respectively (377). Neochamaejasmin B and chamaechromone inhibited the growth of *Bakeri rehm, Fusarium graminearum, Alternaria solani, Fusarium bulbigenum, Exserohilum turcicum, Alternaria alternata* and *Phytophthora capsici* (394). *S. chamaejasme* inhibited the cell proliferation of mice liver cancer H22 cells in a dose-dependent manner (395). The ether and acetone extracts of *S. chamaejasme* were found to be anti-epileptic (396). Six biflavonoids chamaejasmin, 7-methoxyneochamaejasmin, 7-methoxychamaejasmin, chamaejasmenin B, chamaechromone, wikstrol A from *S. chamaejasme* are shown to possess superior aldose reductase inhibiting activity making them useful in diabetic complications such as neuropathy, neophropathy, retinopathy and cataract formation (397). *In vitro* bioassays showed that pimelea factor P2 inhibited cancer cell growth, daphniretin exhibited immunomodulatory activity and (+)-3-hydroxy-1,5-diphenyl-1-pentanone exhibited both immunomodulatory and antitumor activity (387). Two isolated compounds, 4', 4''', 5, 5'', 7, 7''-hexahydroxy-3-3''-biflavone and (−)-pinoresinol had antibacterial properties whereas four others, ruixianglangdusu A and B, (+)-matairesinol and (−)-eudesmin displayed immunomodulatory activity (383).

Swertia ciliata

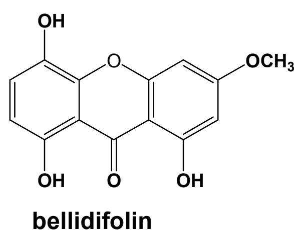
Swertia ciliata (D. Don ex G. Don) B. L. Burtt (Gurung language: *Tiktha*) belongs to the family Gentianaceae. It is available in Afghanistan and the Himalayan region (Kashmir to Sikkim) at the altitude range of 2800 to 4000 meter.

Traditional use in Manang

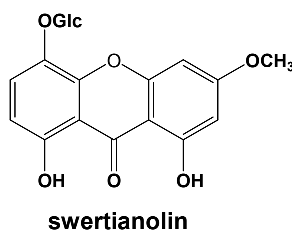
Powdered whole plant is taken with either hot water or milk to treat the conditions related to cold & cough, headache, jaundice, malarial fever and diabetes.

Chemical constituents

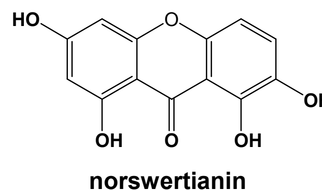
S. cilitata contained xanthones such as bellidifolin, swertianolin, norswertianin and 1,8-dihydroxy-3-methoxyxanthone-7-*O*-glucopyranoside together with oleanolic acid, 3β,28-dihydroxyoleanane-3-palmitate and β-sitosterol (398). The structures of three isolated xanthones are presented below.



bellidifolin



swertianolin



norswertianin

Biological properties

Xanthones such as swertianolin, norswertianin, bellidifolin and swertianin isolated from *S. ciliata* had elevated antibacterial and antifungal properties (399). These xanthones contained irritant properties as well (400). Tetraoxygenated xanthones have diverse biological properties such as hypoglycaemic, antihepatotoxic, antimalarial, anti-inflammatory, antioxidant, antimicrobial and antitumour properties (401).

Swertia racemosa

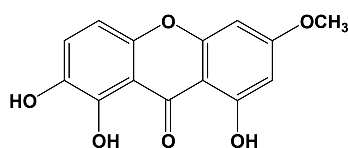
Swertia racemosa (Griseb.) C. B. Clarke (Gurung language: *Lakhetiktha*) belongs to the family Gentianaceae. It is found in the Himalayan region (Nepal to Bhutan), Assam and south east Tibet at the altitude range of 3000 to 5000 meter.

Traditional use in Manang

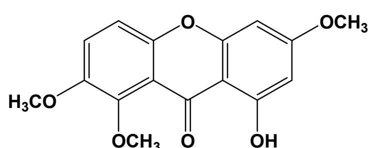
Powdered whole plant is taken with either hot water or milk to treat the conditions related to cold & cough, headache, jaundice, malarial fever and diabetes.

Chemical constituents

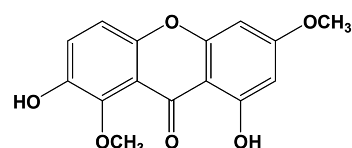
Xanthones such as norswertianin, swertianin, methylswertianin, gentiacaulein, decussatin, demethylbellidifolin, bellidifolin and methylbellidifolin together with oleanolic acid were found in four types of the Nepalese swertia species including *S. racemosa* (402). The structures of three isolated xanthones are presented below.



swertianin



decussatin



gentiacaulein

Biological properties

Tetraoxygenated xanthones are reported to contain varied biological properties such as hypoglycaemic, antihepatotoxic, antimalarial, anti-inflammatory, antioxidant, antimicrobial and antitumor properties (401).

Taraxacum tibetanum

Taraxacum tibetanum Hand.-Mazz. (Gurung language: *Khurmang*) belongs to the family Compositae. This plant is available in the Himalayan region (Nepal to Bhutan), Tibet and China at the elevation range of 4000 to 4300 meter.

Traditional use in Manang

Powdered leave, stem and flowers are taken with hot water for the treatment of gastritis, jaundice fever, fever coming from inner bone and vertigo/dizziness.

Chemical constituents and biological properties

Chemical and biological studies are lacking in this plant.

Taxus wallichiana

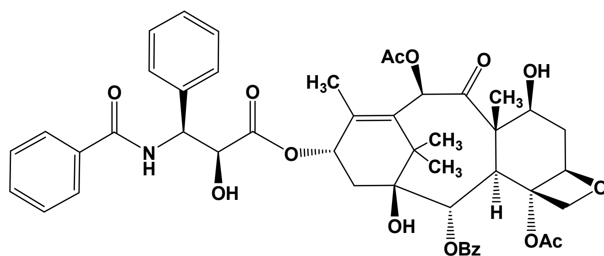
Taxus wallichiana Zucc. (Gurung language: *Silingi*) belongs to the family Taxaceae. It is distributed in the Himalayan region (Nepal to Bhutan), Tibet and west China at the altitude range of 1500 to 3500 meter.



Taxus wallichiana

Traditional use in Manang
Powdered leaves and stems are taken with hot water for the treatment of symptoms of cancer. Amchis keep its uses secret.

Chemical constituents
Taxol is the most famous compound of the plant. Several taxane derivatives (taxol like compounds) with the various carbon skeletons along with lignans, flavonoid, steroids and sugar derivatives have been isolated from the plant (403), (404). *T. wallichiana* leaves produced essential oil containing sixty-two components of which the major components were (*E*)-2-octen-1-ol (14.5%), *n*-pentacosane (8.1%), caryophyllene oxide (7.1%), 1-octanol (6.5%), hexanoic acid (5.5%) and (*Z*)-3-hexenol (4.1%) (405). The structure of taxol is given below.



taxol

Biological properties
Taxol has been described as one of the most celebrated anticancer drug (406), (407). Taxol is especially useful against breast and ovarian cancers.

Thalictrum cultratum

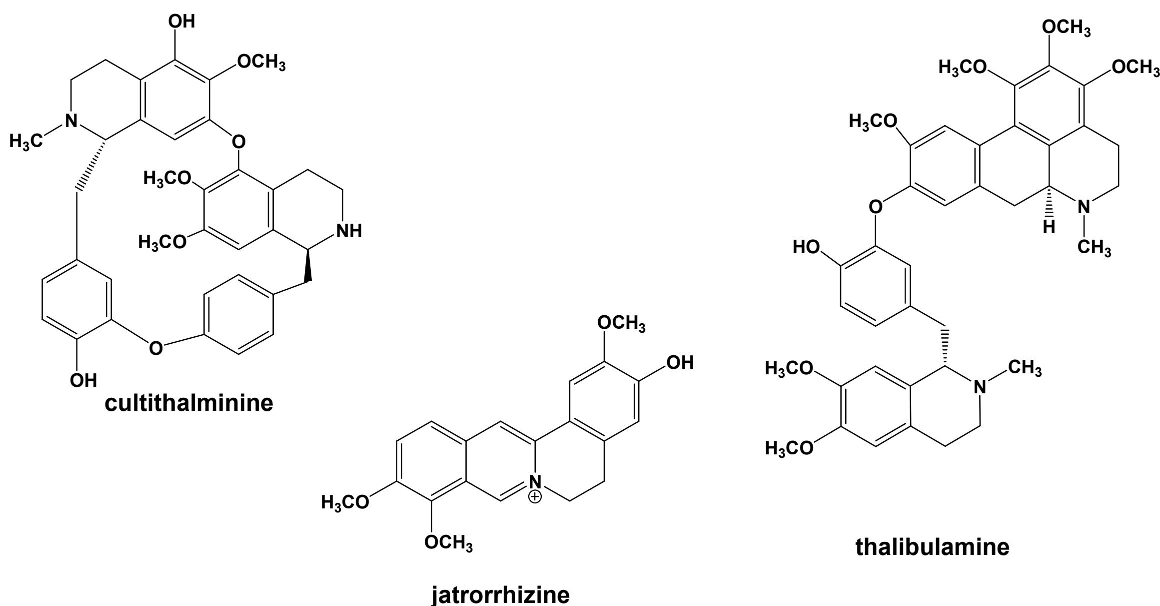
Thalictrum cultratum Wall. (Gurung language: *Nagghunensa*; Amchi term: *Aotin chauque*) belongs to the family Ranunculaceae. It is distributed in the Himalayan region (Kashmir to Bhutan), south east Tibet and west China at the elevation range of 2400 to 4200 meter.

Traditional use in Manang

Decoction of leaves and flowers is useful for the treatment of fever. Leaves and flower paste finds application in boils, wounds and other skin diseases (ring worm and blister). In case of domestic animals such as horse, yak, mule suffering from diarrhea, its leaves and flowers are cooked with wheat flour and water. Animals are fed with this preparation of the food.

Chemical constituents

The plant is rich in alkaloids. Several quaternary alkaloids such as berberine, palmatine, jatrorrhizine, columbamine, thalifendine and (+)-thalidastine as well as the aporphine (+)-magnoflorine have been obtained from *T. cultratum* roots (408). Furthermore, *T.cultratum* have afforded bisbenzylisoquinoline alkaloids such as (+)-2'-noroxyacanthine, (+)-2'–northaliphylline, (+)-cultithalminine, (+)-neothalibrine-2'-α-*N*-oxide, (–)-thalrugosaminine-2-α-*N*-oxide, (–)-thaligosine-2-α- *N*-oxide, (+)-thaliphylline-2'-β-*N*-oxide, (+)-thalidasine-2-α-*N*-oxide and (–)-5 -hydroxythalidasine-2-α-*N*-oxide (409). Some other isolated alkaloids belonging to bisbenzylisoquinoline type are (–)-thalmiculine, (–)-5-hydroxythalmine, (+)-thalmiculatimine, (–)-thalmiculimine and (–)-5-hydroxythalidasine (410). Alkaloids belonging to the class aporphine-benzylisoquinolines such as (+)-thalibulamine, (+)-thalifaronine, (+)-thalifaramine, (+)-thalifaretine, (+)-thalifaricine, (+)-thalifarazine and (+)-thalifaroline have also been obtained from *T. cultratum* (411). The structures of representative alkaloids are presented below.



Biological properties

T. cultratum is shown to contain anticancer activities (194). Its methanol extract contained strong antiviral activity (15). Some of the alkaloids obtained from *T.cultratum* were cytotoxic and antimalarial (412).

Thymus linearis

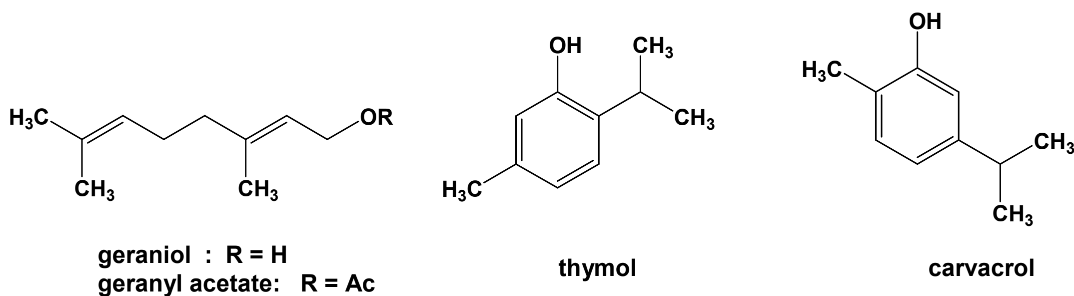
Thymus linearis Benth. (Gurung language: *Akhino*; Amchi term *Macto*) belongs to the family Labiatae. It is distributed in Afghanistan, Pakistan, the Himalayan region (Kashmir to Bhutan), Tibet, India, China and Japan at the altitude range of 2400 to 4500 meter.

Traditional use in Manang

Either decoction of leaves, stems and flowers or powdered leaves, stems and flowers with boiled water is taken for the treatment of the eye pain and conjunctivitis (swollen, red and dirty eyes). Powdered leave, stem and flowers are also useful for gingivitis, increasing the blood and in the condition of dyspepsia.

Chemical constituents

Studies on the ethyl acetate extract of the flowers and leaves of *T. linearis* collected in Karakoram Himalayan region revealed that there exist two chemotypes of this plant, one thymol/carvacrol type and the other geraniol/geranyl acetate type (413). The structures of these reprentative compounds are presented below.



Biological properties

The plant as well as the major constituents is found to be potent fungicides (414). Its essential oil inhibited the mycelial grouth of a phytopathogenic fungus, *Aternaria brassicicola* (35). The methanol extract showed anti-herpes viral activity (15).

Valeriana jatamansii

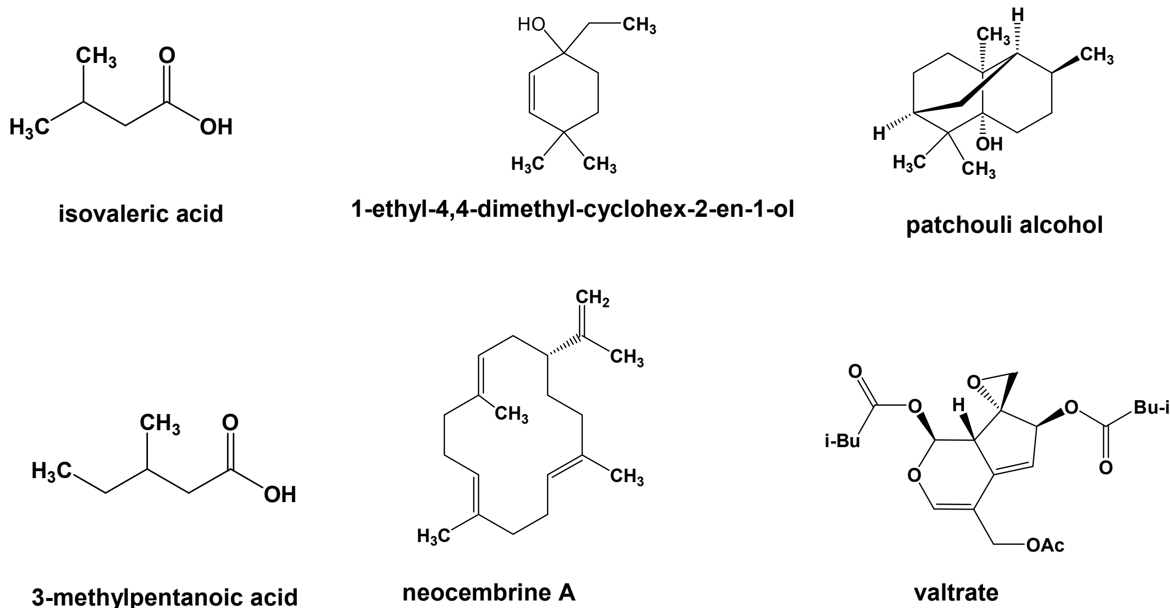
Valeriana jatamansii Jones (Synonym: *Valeriana wallichii* DC.) (Gurung language: *Nappu*) belongs to the family Valerianaceae. It is distributed in Afghanistan, the Himalayan region (Kashmir to Bhutan), Assam, Tibet, Myanmar, western and central China at the elevation range of 1500 to 3000 meter.

Traditional use in Manang

Powdered root is taken with hot water to cure cold & cough, headache, tonsilitis, eye pain, conjunctivitis and infected wound.

Chemical constituents

V. jatamansii volatile oil is found to contain seventy-two compounds. Among them, sixty one compounds were identified of which major components were isovaleric acid (52.95%), patchouli alcohol (18.20%), 3-methyl pentanoic acid (6.89%), 1-ethyl-4,4-dimethyl-cyclohex-2-en-1-ol (3.27%) and neocembrene A (2.12%) (415). *V. wallichii* DC leaf essential oil from northwestern Himalayas had twenty components of which 3-methylvaleric acid (26.5%) and maaliol (39.2%) were the principal constituents. Maaliol (64.3%) and *β*-gurjunene (7.2%) were the main constituents in its root essential oil (416). Valepotriates have been detected in the aerial parts of *V. jatamansii* (417). Iridoids such as 1-homoacevaltrate, 11-homohydroxyldihydrovaltrate, 10-acetoxy-1-homovaltrate hydrin and 10-acetoxy-1-acevaltrate hydrin together with valtrate, isovaltrate, homo-valtrate, acevaltrate, dihomovaltrate, didrovaltrate, 1-homodidrovaltrate, 9-acetylhydroxyldihydrovaltrate, 10-isovaleroxyvaltrate hydrin and 10-isovaleroxydiavaltrate hydrin have been obtained from its rhizome (418). Sesquiterpenes like valeriananoids A, B and C were also isolated from *V. jatamansii* rhizome (419). From the rhizomes and roots of *V. jatamansii*, flavone glycosides, acacetin 7-*O*-*β*-sophoroside and acacetin 7-*O*-(6″-*O*-*α*-l-rhamnopyranosyl)-*β*-sophoroside have been isolated (420). The structures of its volatile oil components as well as of valtrate are given below.



Biological properties

V. wallichii DC essential oil contained potent antifungal efficacy (421). The essential oil was also found to be antibacterial (422). The aqueous extract of *V. jatamansii* together with pentobarbital sodium enhanced sedative and hypnotic effect and inhibited the spontaneous activity in mice as well as antagonized convulsive action induced by thiosemicarbazide (TSZ) (423). *V. jatamansii* forms part of several Chinese medicinal formulations which have been patented. These include formulations for treating cancer (424), a medicated liquor for topically treating rheumatic arthralgia, pain and blood stasis due to traumatic injury, traumatic hemorrhage, sprain, pains in bones and muscles, rheumatic arthritis, and soft tissue contusion (425), a composition for externally treating

rheumatalgia, arthralgia, myalgia, traumatic injury, rheumatism and rheumatoid arthritis (426) and a composition for treating acquired immunodeficiency syndrome (427). It is also a component of perfume preparations (428), (429). From *V. wallichii*, 6-methylapigenin was isolated which functioned as a competitive ligand for the brain GABA(A) receptors (430).

Verbascum thapsus

Verbascum thapsus L. (Gurung language: *Yugisingh*) belongs to the family Scrophulariaceae. It is distributed in the Himalayan region (Kashmir to Bhutan), Tibet and west and central China at the elevation range of 1800 to 4000 meter.



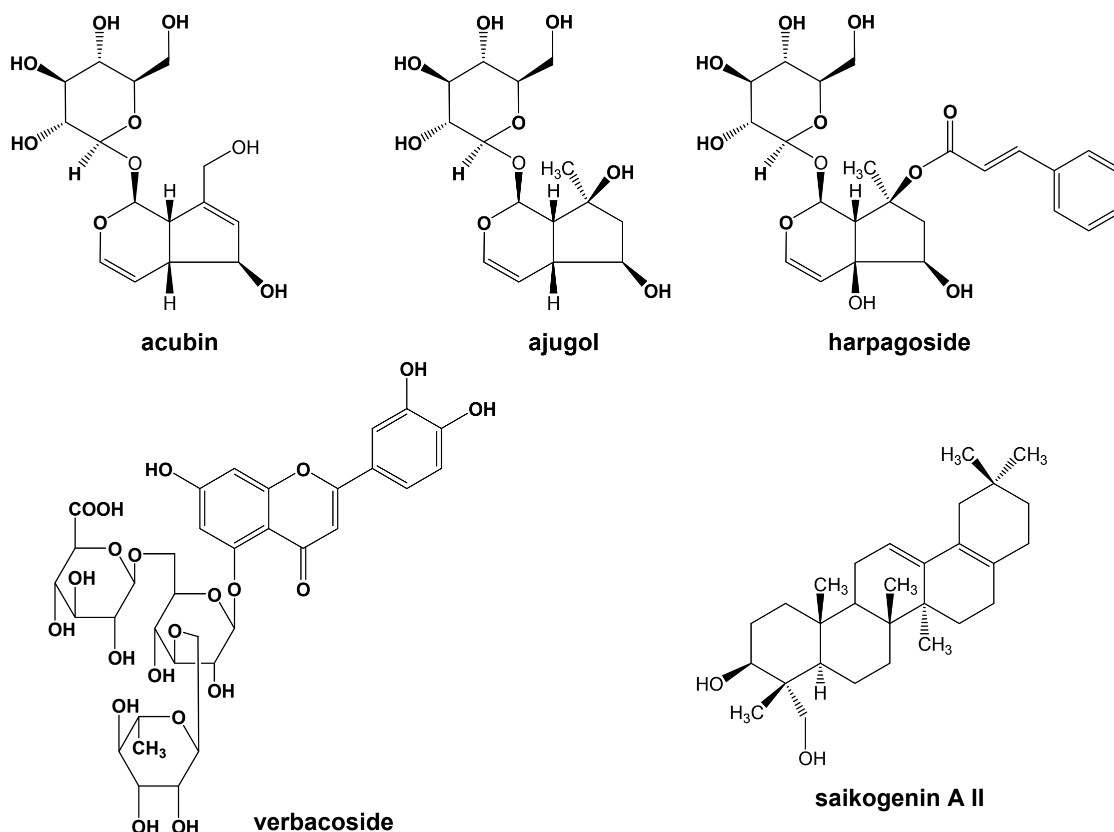
Verbascum thapsus

Traditional use in Manang

Powdered leaves and flowers are taken with hot water for cuts and wounds, urinary diseases (diuretic and dysuria) and edema.

Chemical constituents

Iridoid glucosides, flavonoids, triterpenoids and saponins constitute the major chemical components of *V. thapsus*. From its roots, iridoid glucosides such as laterioside, harpagoside, ajugol and aucubin were obtained (431). Several iridoid glycosides either containing ajugol or 6-*O*-(α-1-rhamnopyranosyl)-catalpol in their structures have also been isolated (432). Triterpenes such as veratric acid and α-spinasterol were isolated from benzene extract of *V. thapsus* whereas the ethanol extract afforded saikogenin A, saikogenins I and II (433). The benzene extract of seed oil of *V. thapsus* contained palmitic, stearic, oleic, linoleic, linolenic, arachidic, and behenic acids and β-sitosterol and ergosta-7-en-3β-ol in the nonsaponifiable fraction (434). An unusual sterone, 24α-methyl-5α-cholestan-3-one, was detected in the plant (435). The ethanol extract of the flowers afforded ergosterol peroxide, docosanoic acid, oleanolic acid, and β-sitosterol (436). A triglycoside of luteolin, verbacoside, (437) and other flavonoids such as 4',7-dihydroxyflavone-4'-rhamnoside, 6-hydroxyluteolin-7-glucoside and 3'-methylquercetin (438) have also been obtained from *V. thapsus*. Four saponins, thapsuine A, thapsuine B, hydroxythapsuine A and hydroxythapsuine B were isolated from *V. thapsus* (439). Several phenylethanoid and lignan glycosides have also been found in *V. thapsus* (440). The structures of representative isolated compounds are presented below.



Biological properties

Water, methanol and ethanol extracts of *V. thapsus* were subjected to antibacterial, antitumor, brine shrimp and radish seed germination inhibition bioassays. All these three extracts inhibited *Agrobacterium tumefaciens* induced tumors in potato disc tissues. Water extract showed antibacterial activity against *Klebsiella pneumonia, Staphylococcus aureus, Staphylococcus epidermidis* and *Escherichia coli*. These extracts were toxic to brine shrimp and to radish seed germination and growth only at elevated concentrations (441). The ethanol extract of *V. thapsus* is found to possess potent antiviral property (442). The decoction of *V. thapsus* flowers induced a factor with interferon-like activity both in cell cultures and in chicken embryos (443). Laterioside, harpagoside and aucubin isolated from *V. thapsus* exhibited antigermination activity on barley seeds (431). Polysaccharides isolated from *V. thapsus* leaves exhibited significant decrease in cholesterol and triglyceride levels in rats (444). It forms a part of otikon otic solution used in ear pain. It was found to be effective as anaesthetic ear drops and was proven appropriate in the management of ear pain associated with acute otitis media (445).

Zanthoxylum armatum

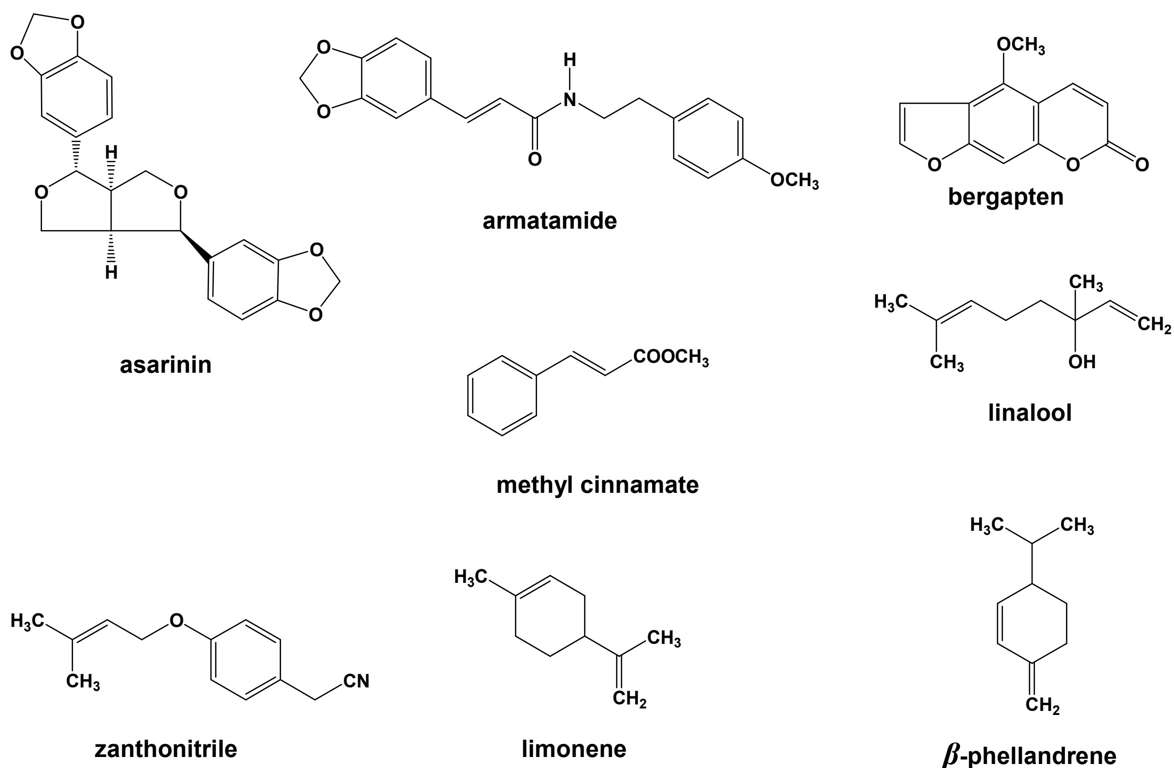
Zanthoxylum armatum DC. (Gurung language: *Prumo*) belongs to the family Rubiaceae. It is distributed in the Himalayan region (Kashmir to Bhutan), north India, east China, Taiwan and the Philippines at the altitude range of 1100 to 2500 meter.

Traditional use in Manang

Pickles are made from the fruits. Pickles are useful for cold & cough, tonsillitis, headache, fever, high altitude sickness, limbs numbness, vertigo/dizziness, diarrhea and dysentery. Powdered dried fruits (without seed) are taken with hot water to cure diarrhea, dysentery and stomachache. The fruits (without seeds) are chewed for gingivitis and other forms of tooth pain.

Chemical constituents

From *Z. armatum*, compounds such as bergapten, umbelliferone, skimmianine, kaempferol, 3,5-diacetyltambulin and zanthonitrile have been isolated (446). An amide named as armatamide along with two lignans, asarinin and fargesin; triterpenes such as α- and β-amyrins, lupeol as well as β-sitosterol-β-D-glucoside were obtained from bark of *Z. armatum* (447). Furthermore, its bark also contained β-amyrone, L-sesamin, L-planinin, vanillic acid and β-sitosterol (448). The seeds of *Z. armatum* are shown to possess 6-hydroxynonadec (4*Z*) enoic acid, 8-hydroxypentadec (4*Z*) enoic acid, 7-hydroxy-7-vinylhexadec(4*Z*)enoic acid and hexadec(4*Z*)enoic acid. The major components of the essential oil of the seeds were linalool (58.3%), limonene (24.46%) and methyl cinnamate (8.92%) (449). The essential oil from the pericarp of its fruits was made up of twenty- five components of which linalool (72%), methyl cinnamate (12.2%), limonene (6.2%) and β-phellandrene (5.3%) were the major constituents (450). The structures of representative isolated compounds are presented below.



Biological properties

Z. armatum essential oil demonstrated larvicidal activity against three mosquito species (451). Mustard (*Brassica* sp.) and coconut (*Cocos* sp.) oil bases containing *Z. armatum* are found to keep away the mosquitos (452). Repelling properties of *Z. armatum* essential oil against land leaches have also been reported (453). Powdered crude fruit was found in inhibit acetylcholinesterase in the brain and muscle of an air-breathing *(Heteropneustes fossilis*) and a gill-breathing (*Puntius shalynius*) fishes making it neurotoxic (454). *Z. armatum* essential oil is described to inhibit the mycelial grouth of a phytopathogenic fungus, *Aternaria brassicicola* (35). *Z. armatum* is a part of patented medicinal formulation to treat toothache, bleeding gums, swollen gums and teeth loosening (455). In a hair growth stimulant composition, one of the components is *Z. armatum* (456).

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Chapter 4

Traditional Medicine: Issues and Suggestions

In one piece of writing, the increasing use and popularity of the traditional medicine are described in the following way:

- In China, traditional herbal preparations account for 30-50 per cent of the total medical consumption.
- In Ghana, Mali, Nigeria and Zambia, the first line of treatment for 60 percent of children with high fever resulting from malaria is the use of herbal medicines at home.
- WHO estimates that in several African countries, the traditional birth attendants assist in the majority of births.
- In Europe, North America and other industrialized regions, over 50 percent of the population have used complementary or alternative medicine at least once.
- In San Francisco, London and South Africa, 70 per cent people living with HIV/AIDS use traditional or alternative medicines.
- In Germany, 90 per cent of the population has used a natural remedy at some point in their life. Between the years 1995 and 2000, the numbers of the doctors who had undergone special training in natural remedy medicine has almost doubled to 10800.
- In the USA, 158 million of the adult population use complementary medicines. According to the USA Commission for Alternative and Complementary medicines, US$ 17 billion was spent in traditional remedies in 2000.
- In the United Kingdom, annual expenditure on alternative medicine is US$ 230 million.
- The global market for herbal medicines currently stands at over US$ 60 billion annually and is growing steadily (1).

Although the above points give a glimpse of the growing popularity of the traditional or alternative medicines, several issues linger on their safe utilization. Some of these issues will be discussed in the following section.

4.1 Traditional Medicine Issues

4.1.1 Standardization

For any therapeutic agent to be safe and effective, consistency in the composition and biological activity are crucial. Critics point to difficulties in plant species

identification, same plant growing in different habitats, genetic variability, disparity in the harvesting and extraction processes and uncertainty of the active principle/s as factors contributing to low level of standardization for the botanical medicines (2). By the very nature of the traditional medicines consisting of several plant ingredients, their chemical and biological standardization pose problem. In spite of this, some efforts have been seen directed towards standardizing the traditional medicines. A simple technique such as thin-layer chromatography (TLC) has been employed as a tool to see the indicator or marker component/s in several herbal preparations. For example, high performance thin-layer chromatography has been successfully used to establish the shelf life and uniformity of a popular multy ingredients containing Ayurvedic formulation (3). With the advent of high resolution sophisticated instruments such as nuclear magnetic resonance spectrometer (NMR), mass spectrometer (MS), infrared spectrometer (IR), ultraviolet/ visible (UV/Visible) spectrometers as well as separating techniques like gas chromatography (GC) and high-performance liquid chromatography (HPLC), used alone or used in combination with the detecting instruments, at all levels of the preparation of herbal products such as the extraction, fractionation, isolation and structure elucidation, control of the quality of the raw materials as well as the finished products have become feasible (4). To give an example, valerenic acid and acetoxyvalerenic acid as biomarkers were found to be present in *Valeriana officinalis* extracts, granulation and tablets of the valerian root in lot-to-lot batches as evidenced in the chromatographic finger printing done with high-performance liquid chromatography (HPLC) combined with an ultraviolet detector (5). Similarly, high-performance liquid chromatography (HPLC) has been successfully applied as a tool for the chemical standardization of Triphala – a popular Ayurvedic formulation (6). DNA technology has come to rescue of the herbal resources. Molecular markers of primary metabolites such as DNA markers provide valuable information about the identity of the plant. Because each species has unique genetic make-up usually unaffected by age, physiological and environmental conditions, for validation and verification of the medicinal plant species, DNA-based techniques are being extensively used (7).

4.1.2 Safety

Safety of the herbal preparations is of the utmost significance. Herbalists believe that because the medicinal plants have been in use since time immemorial, they are devoid of toxicity or have very little toxicity. But one has to keep in the mind that this may not be always the case. If the indication of toxicity is found in the plant, methodical examination should follow. More importantly, deliberately or not deliberately, herbal products are now and then found to be laced with the adulterants and contaminant. The table in page 155 shows a list of potential adulterants and contaminants, which can affect the quality of the herbal remedies (8).

News of herbal products contaminated with heavy metals is not new. In 2004, a paper published in the *American Journal of Medical Association* reported that among Ayurvedic herbal medicinal products produced in South Asia and available in Boston South Asian grocery stores, one-fifth possessed unsafe levels of lead, mercury and/or arsenic (9). One another study again surfaced in 2008 suggesting that twenty percent of

Ayurvedic medicines either manufactured in India or in the United States of America obtained from the internet had detectable level of lead, mercury and arsenic (10). To this news, there was immediate rebuttal from Department of Ayush, the Government of India. Department of Ayush's position was that the Ayurvedic products are clean and non-toxic. The products used in the study were obtained from the internet and their origins, therefore, were dubious. Furthermore, for the manufacture of a few of medicines such as *Akangvir ras*, *Agnitundi bati*, *Arogyavardhini bati*, herbo-metallic compounds are required. They are introduced after proper detoxification. Such medicines have not seen to elicit any significant adverse drug reactions so far (11). Indian Government has issued strict test of the heavy metals on the Ayurvedic medicines bound abroad. The Chinese traditional medicines are also no exceptions in this respect. They are shown to contain heavy metals (12). Steroids were found in Chinese herbal creams (13).

Potential Adulterants and Contaminants of Herbal Remedies

Type of Adulterant/Contaminant	Example
Botanicals	Aristolochia, digitalis, colchicum, rauwolfia, plants containing belladonna or pyrrolizidine alkaloids
Microorganisms	*Staphylococcus aureus*, *Escherichia coli*, salmonella, shigella, *Pseudomonas aeruginosa*
Microbial toxins	Aflatoxins, bacterial endotoxins
Pesticides	Chlorinated pesticides, organic phosphates, carbamate, insecticides and herbicides, dithiocarbamate fungicide, triazin herbicides
Fumigation agents	Ethylene oxide, methyl bromide, phosphine
Toxic metals	Lead, cadmium, mercury, arsenic
Drugs	Analgesic and anti-inflammatory drugs (e.g., aminophenazone, phenylbutazone, indomethacin), corticosteroids,benzodiazepines, warfarin, fenfluramine

Admittedly, all types of drugs including herbal medicines should be subjected to rigorous scrutiny. Contamination of any sort is completely unaccepted. However, faults found in some batches of herbal medicines should not be equated with fallacy in such traditional medical practices, which have survived since ages. What is important is that unscrupulous practices should be brought to notice and necessary actions deem necessary so that traditional healing will not get a bad name.

Another concern of safety is about the potential interaction between the herbs and the conventional drugs leading to unwarranted pathological situations. For example, Ginkgo leaf when taken together acetylsalicylic acid (aspirin) brought about bleeding and St. John's wort elicited phototoxic reaction on exposure with 5-aminolevulinic acid (14). In order to mitigate the problem of interaction between herbal medicines and synthetic drugs, it is imperative that physicians enquire with the patients whether they have been taking

herbal remedies before prescribing the modern medicines. Not only this, physicians should also be aware of the repercussions of the potential drug and herb interaction.

4.1.3 Efficacy

Double-blind (placebo controlled) experiments are key to assess the efficacy of the medicinal substances. In such experiment, the subjects are divided into two groups, one-half receives the actual medicine being tested and the other half are given the actual substance look like materials called placebo with no healing properties but are safe. The subjects do not know whether they are taking real thing or the fake ones. In addition, the researchers doing the experiment will also not know who is receiving the real treatment and who is receiving the fake treatment. This makes the whole process double blind. If beneficial effect greatly outweighs in the real treatment group than in the fake (placebo) group, the substance being treated would be considered as having therapeutic value. In case of the herbal medicines, the World Health Organization (WHO) has recommended that for a herbal drug with established history of use, it is deemed ethical to go to clinical trial 3 right from animal toxicity tests skipping clinical trial phases 1 and 2 (15). Few some sort of clinical studies with double-blind (placebo controlled) trials on the herbal remedies are available. These include the herbal remedies such as Ginkgo leaf (*Ginkgo biloba*) for dementia (16), St. John's wort (*Hypericum perforatum*) for depressive disorder (17), Ginseng (*Panax ginseng*) as a tonic (18), Feverfew leaf (*Tanacetum parthenium*) for migraine headache (19), Garlic bulb (*Allium sativum*) for hypercholesterolemia (20), Valerian root (*Valeriana officinalis*) as a sedative and sleeping aid (21), Ginger root (*Zingiber officinale*) for nausea and vomiting (22), Kava rhizome (*Piper methysticum*) to reduce anxiety (23), Echinacea (*Echinacea purpura*) for prevention and treatment of common cold (24) and Saw palmetto fruits (*Serenoa repens*) for benign prostatic hyperplasia (25). Several of these studies are criticized for lacking standardization and quality control of the herbal remedies used in the clinical trial, herbal medicine's differing doses, insufficient number of patients, inadequate randomization and problematic placebos because of color, taste and aroma (26).

One thing, however, needs to be emphasized. Beneficial properties of these herbal remedies are known since time immemorial. If modern science provides credence to their uses, even in modest way, this has to be taken first step for their efficacy. Then, further refined tests should follow. In this context, one another thing often argued by the traditional practitioners is that perhaps the clinical tests designed for modern medicines would not fit for the herbal medicines. A different approach of the clinical test may be required in case of the herbal medicines. Some conservative traditional practitioners even suggest that the modern science lacks the tools to judge the efficacy of the traditional medical systems. They hold that when a system does not believe on the existence of the microbes, what is the use of studying the antibacterial properties of a plant used in the traditional medicine.

For the validation of this traditional therapeutics, my argument will be that these plants should be exposed to modern scientific tools and methodologies as much as possible. Double-blind placebo-controlled clinical trials along with pharmacokinetic and bioavailability studies will enhance the recognition of the herbal medicines. Finding

utility in the realm of science should be of paramount priority. A happy marriage between traditional wisdom and modern science is what is needed.

4.1.4 Biodiversity

Most of the herbs in trade are harvested from the wild. In many countries like Nepal, earnings from collecting the herbs provide subsistence income for poor disadvantaged groups of the community. Government too earns money from the royalties from their collection and export. Excessive uncontrolled harvesting is thought to put the beneficial plant species on risk of depletion. Greed on the level of the middlemen and ignorance on the level of the harvesters are often blamed for this. However, stories on the other side of the coin are also on hand. People have also argued that the contribution for biodiversity loss by medicinal plant hunters is miniscule compared to other human activities such as road construction, dam construction, logging activities and others. When the harvesters know that his or her livelihood is connected with the medicinal plant resources in the backyard, it is most likely that he or she would be expected to take utmost care of these natural resources. A thought provoking article appeared in 2007, which challenged the widely held four common assumptions in relation to the medicinal plant collection and trade in Nepal (27). The paper argued that these four assumptions (a) collection of the medicinal plants is shrinking the medicinal plant resource base (b), the medicinal plants constitute an open-access resource (c), conservation of commercially exploited medicinal plants can be done through cultivation and (d) middlemen cheat medicinal plants harvesters lacked rigorous empirical evidences. Perpetuation of these assumptions, the article maintains, has led to existing top-down approach of commercial medicinal plant conservation which has manifested in the control of the harvesters as well as shifting the focus on the cultivation of the medicinal plants in order to reduce pressure on wild harvesting of the medicinal plant resources. The article ends like this " if sustainable management of commercial central Himalayan medicinal plants is to be achieved, future conservation efforts need to be based on scientifically valid data, build on community participation and take place at the regional rather than national level".

4.1.5 Recognition

Largely how much impact traditional medicine will have on heath care delivery depends upon how the Government has looked on the particular traditional medical system as well as how the public at large perceives the traditional medicines. Has the system obtained official status from the Government? Traditional medicine maintains different modes of official recognition such as the integrative system (official recognition as well as acceptance in all areas of health care delivery system such as treatment, education, training, regulation, insurance etc) as in China, Korea and Vietnam; the inclusive system (official recognition but has not penetrated in all areas of the health delivery system) as in India, Nigeria, Mali, Canada and the UK and the tolerant system (principal health care delivery system is allopathic system with some tolerance of the traditional medical practices) as in Italy (28). My personal observation indicates that the traditional medicine such as the Ayurveda in Nepal lacks the level of popularity as it has in India. In case of Nepal, the Government has sponsored the Ayurveda, Homeopathy and

Unani hospitals. Tibetan medicine is not officially recognized. The Himalayan Amchi Association based in Kathmandu is lobbying for the official recognition of the Tibetan medicine.

4.1.6 Regulation

Regulatory arrangement of the herbal medicines is essential to ensure its safety and efficacy. It furthermore lends credence and confidence to the quality of the product. Countries have various modes for regulating the herbal medicines (29). World Health Organization (WHO) has come up with a set of guidelines for quality, safety and efficacy for herbal products addressed to national regulatory authorities, scientific organizations and manufacturing units (30). The following is the descriptions of the regulatory practices of some countries around the world.

Let us first see China. In 1963, the *Chinese Pharmacopoeia* came into existence. In the same year, national regulations on conventional pharmaceuticals as well as on the herbal medicines were promulgated. Herbal medicines manufacturers are required to follow the information contained in the pharmacopoeias and adhere to the same GMP (good manufacturing practices) rules applicable to the conventional pharmaceuticals. Safety assessment requirements are same as for the conventional pharmaceuticals and one more requirement, traditional uses of the herbal products with no harmful effects need to be demonstrated. Herbal medicines find places in the pharmacies as prescription medicines as well as over-the-counter medicines to be handled by the licensed practitioners.

In Brazil, registration of the herbal medicines started in 1995. Herbal medicines are called phytopharmaceutical products. They are defined as the processed drug containing active ingredients exclusively from the plant materials and/or plant drug preparation intended to treat, cure, alleviate, prevent and diagnose diseases. For their registration, a thorough documentation of efficacy, safety and well-defined quality control of the herbal medicines are obligatory. For the herbal products with recognized history of traditional use, proof of 5 years of safety and 10 years of efficacy assessment are required. However, this law has not been put into effect because of the opposition from some companies.

In the United States of America, the herbal medicines are classified as the dietary supplements under the Dietary Supplement Health and Education Act of 1994. They do not fall under the jurisdiction of the Food and Drug Administration. Dietary supplements are food or food ingredient that provides a health benefit beyond the nutrients it contain and therefore are not for diagnose, treat, cure or prevent diseases.

In case of Nepal, pharmacopoeia is absent. The regulation of the herbal medicines as well as conventional medicines is in accordance with the Drug Act of 1978. The regulatory and safely requirements of the herbal medicines are same as that of the conventional medicines such as sticking to the information contained in standard pharmacopoeias or monographs and following the GMP practices. In case of the herbal products, references of scientific research on the product and its traditional use cited in the past literature as well as proof of its traditional use with no harmful effects are necessary. Licensed practitioners sell the herbal medicines as prescription drugs or over-

the-counter medicines in the pharmacies. However, the herbal medicines are also found to be sold by the street hawkers freely.

4.1.7 Traditional medicine in Coming Years

It has been argued that the traditional medicine has good potentiality to contribute towards drug discovery in the twenty-first century. Let us see how (31). Two paradigm shifts in the field of medical treatment are slowly occurring in the twenty-first century. The first is that the medical treatment is gradually moving towards multidrug therapy rather than the usual dependence on the treatment by monosubstance. The other one is that multitarget therapy with emphasis on protective, repair and immunostimulatory mechanisms of the human body is being preferred over single disease curing agent. Keeping in mind that the traditional formulations are multisubstance in nature and are known to bring sense of well-being in human in holistic manner, in both fronts, traditional medicines stand a good chance in contributing useful drug/s. However, one has to keep in the mind that modern science has to validate such drugs from nature if they are discovered. Therefore, side by side, better standardization methods of such preparation need to be developed. Molecular level bioassays should be tied up with the plant screening process. Such drugs, needless to say, are required to pass single or double-blind placebo-controlled clinical trials as well as pharmacokinetic and bioavailability studies.

4.2 Suggestions for the Sustainable Development of Medicinal Plant Resources and Traditional Medicines

Having been acquainted with some of the basic issues on the safe use of the traditional medicines, in the next section, I will dwell little bit on what should be done to sustain, promote and develop medicinal plant resources & traditional medicine in Nepal. My suggestions in this respect are as follows.

a) Local people should be made master of the natural resources: The local people who live in or in the hinterland of the natural habitat and who have traditional knowledge and experiences of the dynamics of the ecosystem should be entrusted with the management of the natural resources. These indigenous communities possess age-old cultural knowledge and skill of caretaking the natural resources being in complete harmony with nature. They know best the value of sustainable use of the natural resources, their bread and butter. Perhaps what they need is the information of the market and some kind of the micro credit to start their business. Environment has to be created in a way that they are not cheated. Perhaps they need to be taught about better ways of the drying and storage of their collection. Outside intervention should be limited to make their endeavor more profitable and scientific.

One another thing needs mention here. Now and then, we are hearing that license to harvest one thing is obtained from the Government, by colluding with the corrupt local

officials, some valuable some times even protected plants are collected by unscrupulous intermediaries. Memory is still fresh that some years ago, several truckloads of the banned lauth salla (*Taxus wallichiana*) were confisticated at Nepal-India border. Such things have better chance of checking if the local inhabitants were made in charge of the natural resources.

b) Meticulous scientific study of the medical plants is deemed essential: A painstaking study of the medicinal and aromatic plants in terms of their availability & distribution, harvesting pattern, their internal and external trade demand and possibility of their domestication and cultivation needs to be carried out. Then only, we will know where we stand in terms of status of the medicinal plants in the country. Based on this, a workable medicinal plant policy at the Government level can be chalked out. It was very good news that the Government selected thirty herbs as the national priority herbs. Since then, what happened to these priority herbs, people have a vague idea.

c) Value addition to the medicinal plant resources needs to be done at local level: Plants collected at difficult mountainous terrains find difficulties for transportation to the cities in the southern part of the country. In order to reduce the volume as well as to add to its value, distillation plants or extraction units should be established at the local area. The local people are likely to benefit more by this arrangement. The local Government, local entrepreneurs and NGOs could join hands to create such avenues.

d) Medicinal plant resources should benefit the Government, collectors and traders: Economists have been telling repeatedly that by virtue of the ecological blessing, Nepal stands a good chance of becoming a formidable player in the herbal industry regionally and even internationally. What is needed is the right type of the policy and encouragement from the Government. Policy makers should stop giving the lip service and concentrate more on favorable tax incentives for the herbal entrepreneurs and low interest loan for farmers. On one hand, by careful extensive farming of the medicinal plants might open new source of income helping reduce rural poverty and on the other, an energized countrywide herbal entrepreneurship is sure to make a dent on the national economy.

Medicinal plants are renewable resources. The Government should be able to derive utmost royalties from its collection. Judicious scientific judgment should prevail before putting the plant species into ban. Ban will not only curtail Government's royalty but it will harm the collectors and traders as well. Ban is likely to encourage illegal harvesting and trade. If the excessive harvesting is the concern, attention should be directed towards efficient policing, generating favorable public awareness and empowerment of the local people. Moreover, considering the fluctuating market price of the medicinal plants, the price of royalties should be adjusted accordingly. Furthermore, irrational royalty collection and multiple tax levying should be discouraged. In addition, institutional capacity of the relevant Government agencies be it in the plant identification or in medicinal plant trade monitoring or in regulatory business need to be strengthened.

e) Farmers should be encouraged for medicinal plant farming: Usually farmers are reluctant to try new things and are happy with what they are doing in the past. Motivation to try out new things should be infused in the farmers. Success stories of the medicinal plants farming should be narrated to the farmers. Stories like the farmers from Myagdi district benefited from the timur (*Zantholyxum aratum*) farming (32) and many others need to be circulated widely. Good techniques of the farming should be introduced. Farmers should be trained on good practices of plant cultivation, harvesting, storage and packaging. If the plants could be grown in organic farms, that will add to international salableness. Plants, which are imported for domestic herbal enterprises and plants exported in bulk should be in the priority list. The possible buyers of the medicinal plants need to be identified before hand. Perhaps the local Government and district forest and agriculture departments could take lead on this.

f) Traditional medicine should be taken seriously: On one hand, we say that around 70% of the people depend upon the traditional medicine in one way or the other for primary health care showing its importance, on the other, traditional medicine is very lightly taken by the Government and city people alike. Now and again, traditional medicine and its practitioners are looked down in the cities. Modern physicians and traditional practitioners usually are at odd and do not communicate well with each other. This is certainly not a good situation. What is required is that respectability of the profession from each other and jointly contribute to the national health care system. The Government at best has shown lip services to the traditional medicine. There is little place to disagree with Dr. Kamdev Jha when he says that for a country of around twenty-seven million people, there is just one Ayurvedic campus, one Government Ayurvedic department and one central Ayurvedic hospital and considering the activities of the ministry of health, the ministry should be renamed as medical ministry pointing to the low priority the Ayurveda in particular and other traditional medicines in general enjoys in the ministry (see page 7). We should learn from our neighbors. The respect, status and popularity Ayurveda, Siddha and Unani enjoy in India and the Chinese traditional medicine enjoys in China are just envious. In another neighbor, Bhutan, modern hospital and traditional hospital exist side by side and the patients are free to choose the treatment of their choice. A sound Government level policy on the traditional medicines seems to be lacking. With such policy on hand and pressing for its meaningful execution, the Government will be forced to take traditional medicine seriously. To make lay people interested in the traditional medicines, the beneficial characters of the traditional medicines need to be taken to public through the medium of newspapers, magazines, television, talk programs and community meetings. Perhaps the professional organizations such as Jadi Buti Association of Nepal (JABAN), Nepal Traditional Ayurvedic Medicinal Practitioners Association, Himalayan Amchi Association, Nepal Herbs and Herbal Products Association (NEHHPA) and others should work more vigorously for their justified demands.

Tibetan medicine is practiced in Nepal since long time and is gaining popularity. The Tibetan medicine practitioners are asking for the official recognition. When it is

serving so many Nepali, what is the harm of providing it official status? Discrimination would not help anybody.

g) Investment in the traditional medicine teaching and research should be increased: The Ayurveda campus at Kathmandu has courses up to the graduate level. There is one Homeopathy college in Nepal and one another said to start soon. Tibetan medical education is confined to the basic level only. For a country with a long history of traditional medical systems, such situation seems a little awkward. Higher level of education as well as advanced researches on the traditional medicines are the demand of today. Perhaps time has come to think about the integrative courses of the modern and traditional medicines as practiced in China and India. More investment in the teaching and research in traditional medicines areas are required. Despite the fact that some universities and Government labs are engaged in some sort of the medicinal plant research, it is far from satisfactory. Researches on the plant's chemistry, biology and pharmacology should be priority. One should not forget that researches of this type have produced blockbuster drugs such as vinblastine, vincristine, taxol and many others. It is high time that the country's planners and decision makers give due consideration on this aspect. Recently, one good news came in this direction. The news is that the Government of China is helping build National Ayurvedic Research Center in Nepal to be completed by 2010 (33). It is hoped that more of such good news will follow.

h) GMP practice should be in place: As required by Nepal Drug Policy 1978, strict adherence of the good manufacturing practices (GMP) in the manufacturing units needs to be ensured. In no case, child labor should be involved and tolerated. Heavy metals, pesticides and microbial contamination are taboo in such products. Only when these conditions are fulfilled, international salability of the herbal products would be enhanced. National regulatory agency has enormous task to see that efficacy and safety of the herbal products have not been compromised. Needless to write that massive importance has to be placed on the safety and efficacy of the herbal products.

i) Traditional healers should be involved in primary health care: A vast disparity exists in the health care access in the city and countryside regions of Nepal. Doctors are concentrated in the cities like Kathmandu and are reluctant to go to the remote parts of the country. Furthermore, poor infrastructure as well as inadequate human resources hampers the zonal and district hospitals. In some places, to reach the zonal hospital takes several hours to several days. In the rural areas, the first choice of seeking medication is to go the traditional healers usually the *dhami-jhankris*. If the illness persists, the patient may opt to visit the zonal hospital or district health post.

The traditional healers (*dhami-jhankris*) occupy a respectable position in the village community. The community listens to what the traditional healers say. It is believed that around 444, 000 traditional healers exist all over Nepal. Given their size and the respect they command in the community, their effective contribution in the national primary health care delivery system cannot be ruled out. In fact, several examples around

the world as well as in Nepal have demonstrated the usefulness of the trained traditional healers in the primary health care delivery. To cite some examples, the contribution of trained the birth-attendants *(sudenis*) in the pregnancy and delivery cases (34), trained traditional healers in the community health (35) and eye care services (36) have been well documented. Let us see one example. In one instance, the traditional healers were trained in the preparation of rehydration solution, simple dressings, infant nutrition and scabies treatment as well as safe childbirth practices. The trained traditional healers were relatively useful and had better approval in the rural communities than medical health workers (37).

For successful integration of the traditional healers into primary health care delivery system, giving due importance of health leadership role these traditional healers have in the community, they should be taken into confidence and provided well-designed community specific primary health related trainings. In countries like ours with ever expanding needs with meager resources, services of the trained traditional healers can be harnessed successfully to meet primary health requirements in both culturally fitting and cost effective manner (38).

j) Traditional medicine database and herbal pharmacopoeia need to be produced: One effective way of protecting the traditional medical knowledge from the biopirators is to document the traditional knowledge in written form. This will act as a "prior art" in case some body files patent on these traditional knowledge. The Government of India has already prepared Traditional Knowledge Digital Library. In the Government level, talk could be initiated for getting assistance from Traditional Knowledge Digital Library project of India for making Nepal's Traditional Knowledge database. Furthermore, time for the preparation of the herbal pharmacopoeia of the herbal medicines used in Nepal has perhaps already come. Macroscopical and microscopical descriptions of the herbal material together with application of techniques such as thin–layer chromatography (TLC) and high performance liquid chromatography (HPLC) for chemical and biological standardization, pharmacological activities and required safety measurements could be included in such pharmacopoeia. Japan International Cooperation Agency (JICA) has helped prepare herbal pharmacopoeia in some Asian countries such as the Philippines. Perhaps we can approach the international agencies like JICA. Our Ministry of Environment, Science and Technology could perhaps take lead on this aspect.

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Plant name index

General index

Aspects of Traditional Medicine in Nepal

Edited by SURESH AWALE

This book aims to introduce basic tenets of the traditional medical system of Nepal. It is intended for the general readers, students and anybody who is interested in Nepali traditional medicine and medicinal plant resources. Written in a simple language and lucid way, it contains four chapters. The first chapter describes the status of existing traditional medicines such as Ayurveda, Homeopathy, Tibetan , Unani, Folk and Shamanistic medicines. The second chapter is devoted to the study of Nepali medicinal plants from the perspectives of utilization, conservation, cultivation, trade and sustainable use. To illustrate the importance of the folk medicines, the third chapter deciphers interesting biological properties and chemical structure diversity in the folk medicines practiced in Manang district of Nepal. The final chapter looks into lingering issues on the safe and effective use of the traditional medicines. Furthermore, the chapter includes the author's down to earth suggestions for the sustainable development of the medicinal plant resources in Nepal.

About the author

Educated in India, Nepal, USA and Japan, Professor Mohan Bikram Gewali has been teaching chemistry since last thirty-five years in Tribhuvan University, Kathmandu, Kathmandu, Nepal. Professor Gewali takes keen interest in the chemistry and biology of the medicinal plants. He served as a visiting professor at Institute of Natural Medicine of University of Toyama, Toyama, Japan during the period of November 2007 to March 2009. One of the outcomes of his tenure in Toyama was the production of the present book. Professor Gewali can be reached at the e-mail (mbgewali@gmail.com) address.



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